BAYOU BOEUF
WATERSHED IMPLEMENTATION PLAN

Louisiana Department of Environmental Quality, NPS Unit

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1.0 INTRODUCTION

Louisiana contains extensive areas of water bodies, including wetlands, bayous, rivers and lakes. Surface water in Louisiana is used for a wide variety of purposes such as drinking water, agricultural irrigation, transportation, industrial processes, recreation, seafood production, and wildlife habitat. A great portion of the Louisiana economy and cultural heritage is directly linked to the surface water resources that exist today.

Nonpoint source pollution is a diffuse source of water pollution that occurs when storm water flows across the land, transporting contaminants to a water body. Common land-use categories that contribute to nonpoint source pollution include agriculture, forestry, urban runoff, construction, home sewerage systems, resource extraction, and hydromodification. Detailed explanations of each category can be found in the State of Louisiana Water Quality Management Plan, Volume 6, Louisiana's Nonpoint Source Management, 2000.

The purpose of this report is to outline a plan, which can be implemented with federal, state, and local funds, to reduce the amount of nonpoint source pollution entering Bayou Boeuf and thereby increase water quality to a level where the water body fully meets its designated uses.

Section 319 of the Clean Water Act (CWA) authorizes the Environmental Protection Agency (EPA) to issue grants to states to assist in implementing management programs to control nonpoint sources of water pollution. The 303(d) list of impaired water bodies consists of those water bodies that do not meet state regulatory water quality standards even with the current pollution controls in place and after point sources of pollution have installed the minimum levels of pollution controls.

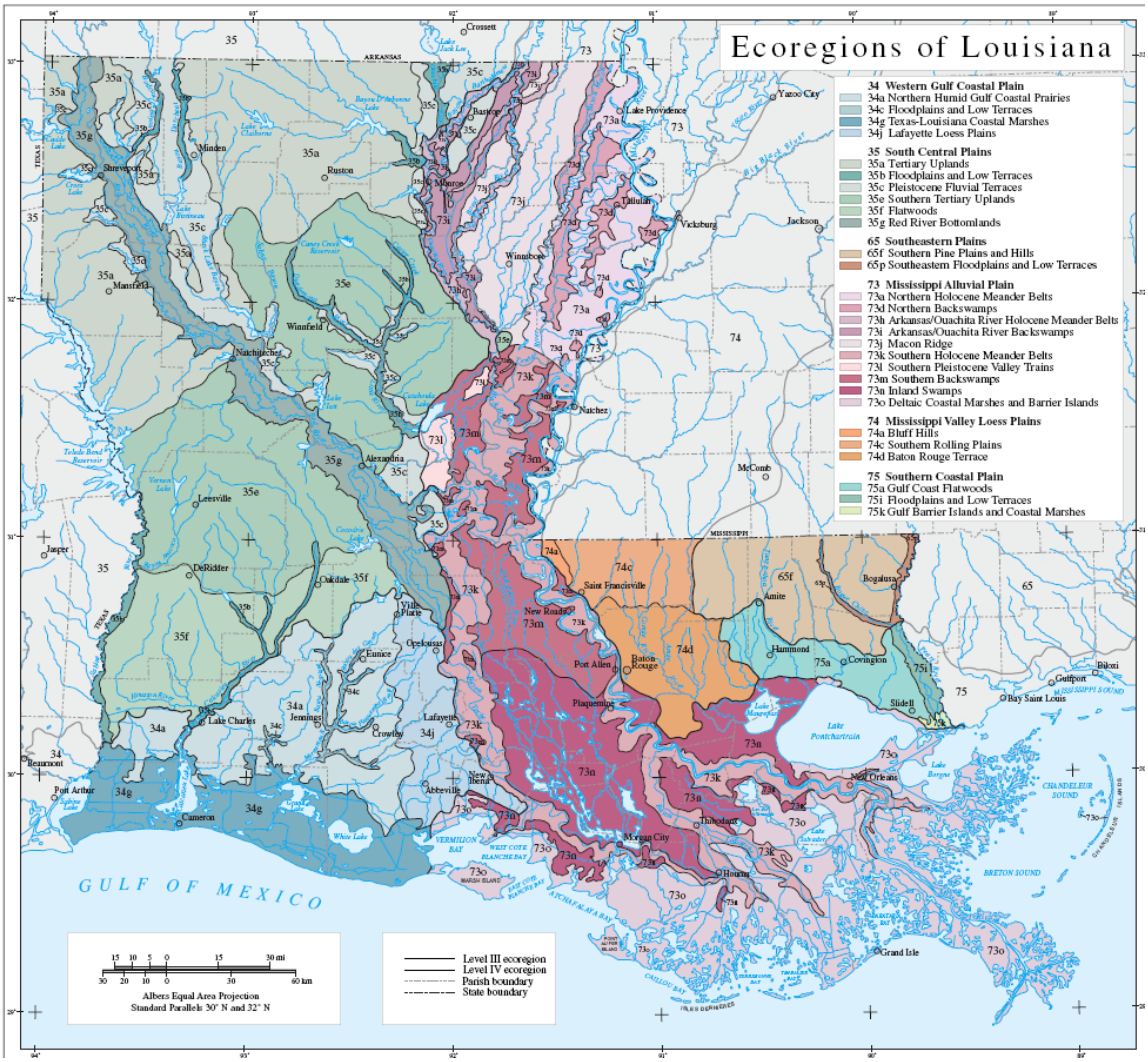
Bayou Boeuf has been cited in the Louisiana Water Quality Integrated Report for failure to maintain its water quality standards for Primary Contact Recreation and Fish and Wildlife Propagation. Suspected causes of impairment include crop production and wildlife other than waterfowl. Because of its failure to support designated uses, TMDLs have been developed for the Bayou. (While the 2008 Integrated Report is still under review at this time, it does indicate the Bayou may be de-listed for primary contact recreation. However, the bayou may meet its designated use for primary contact recreation for the first time in many years.)

Designated uses specific to Bayou Boeuf are primary contact recreation, secondary contact recreation, and fish and wildlife propagation. Primary contact recreation (PCR) includes recreation such as swimming and water skiing. Secondary contact recreation (SCR) is other uses where body contact is incidental such as fishing and boating. Propagation of Fish and Wildlife (FWP) involves the protection of aquatic habitat, food, reproduction and travel corridors.

Table 1 Failure to meet Designated Uses			
Year	Supporting Designated Uses (Yes/No)		
	PCR	SCR	FWP
1998	No	Yes	No
2000	No	Yes	No
2002	No	Yes	No
2004	No	Yes	No
2006	No	Yes	No

1.1. Ecoregion Description

Map of Louisiana Ecoregion



Typified by flat plains, this Western Gulf Coastal Plain ecoregion is located in southwestern Louisiana and ranges westward along the eastern coast of Texas. The southern boundary has been modified to coincide with the location of the Intracoastal Waterway. The eastern boundary is the western Atchafalaya levee system. The northern boundary partially concurs with the divide between the Gulf Coast Flatwood and Coastal Plain soil associations and the original EPA delineation. Vegetation is characteristic of the bluestem/sacahuista prairie type (bluestem and cordgrass) and land-use primarily consists of cropland and cropland combined with grazing land. The soil associations represented in this ecoregion are Gulf Coast Flatwoods and Coastal Prairie.

34. Western Gulf Coastal Plain

The principal distinguishing characteristics of the Western Gulf Coastal Plain are its relatively flat topography and grasslands. Inland from this region, the plains are older, more irregular, and are mostly forested in the Louisiana portion (Ecoregion 35) or savanna-type vegetation to the west in Texas (Ecoregion 33). Largely because of this flat land and relatively fertile soil, a higher

percentage of the land is in cropland than in the bordering ecological regions. Rice and soybeans are the principal crops across the region, while grain sorghum and cotton are also grown, mostly in the Texas portion. Urban and industrial land uses have expanded greatly in recent decades in some parts of the region, and oil and gas production is common.

The Western Gulf Coastal Plain ecoregion comprised of several sub ecoregions. These include:

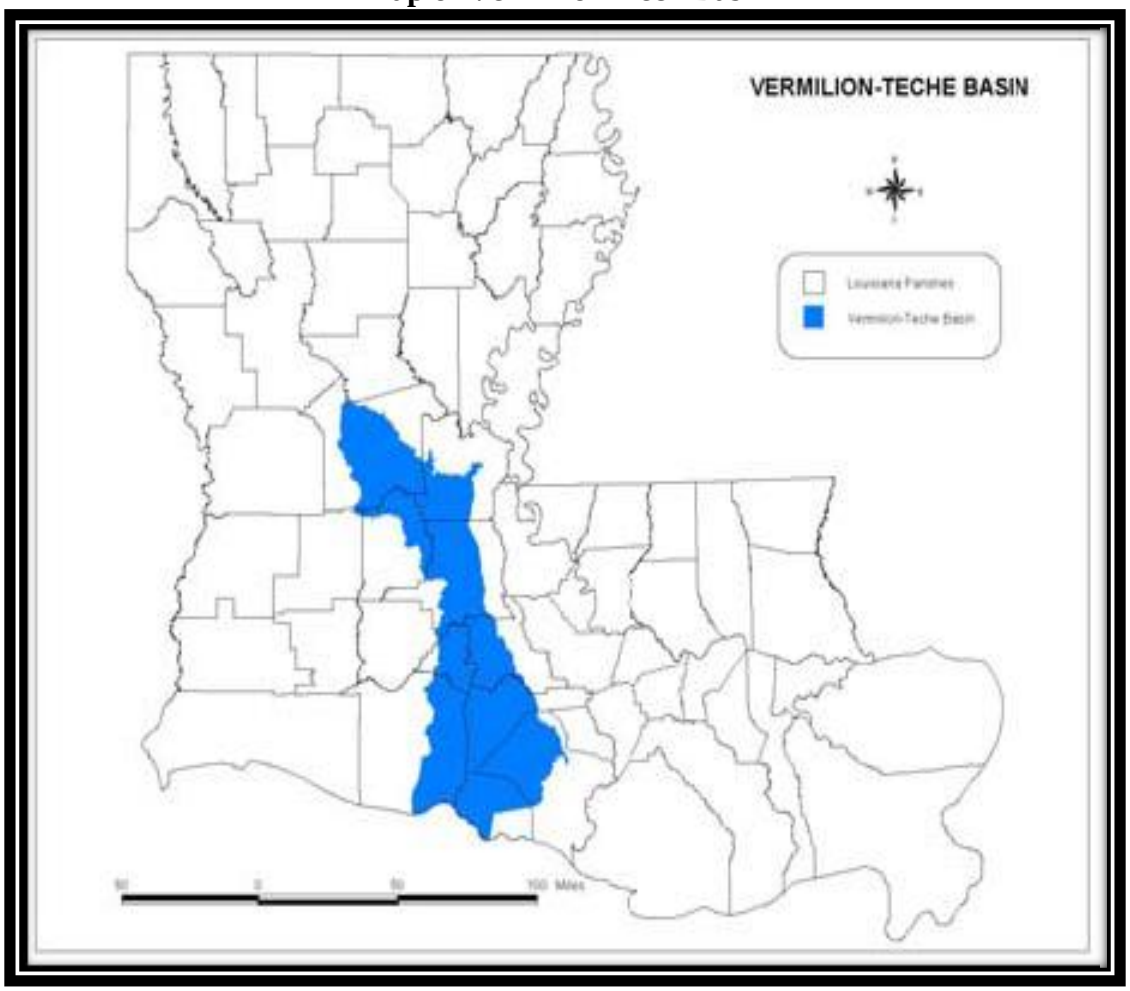
34a. Northern Humid Gulf Coastal Prairies
34c. Floodplains and Low Terraces
34g. Texas-Louisiana Coastal Marshes, and
34j. Lafayette Loess Plain.

1.2. Vermilion-Teche Basin Description

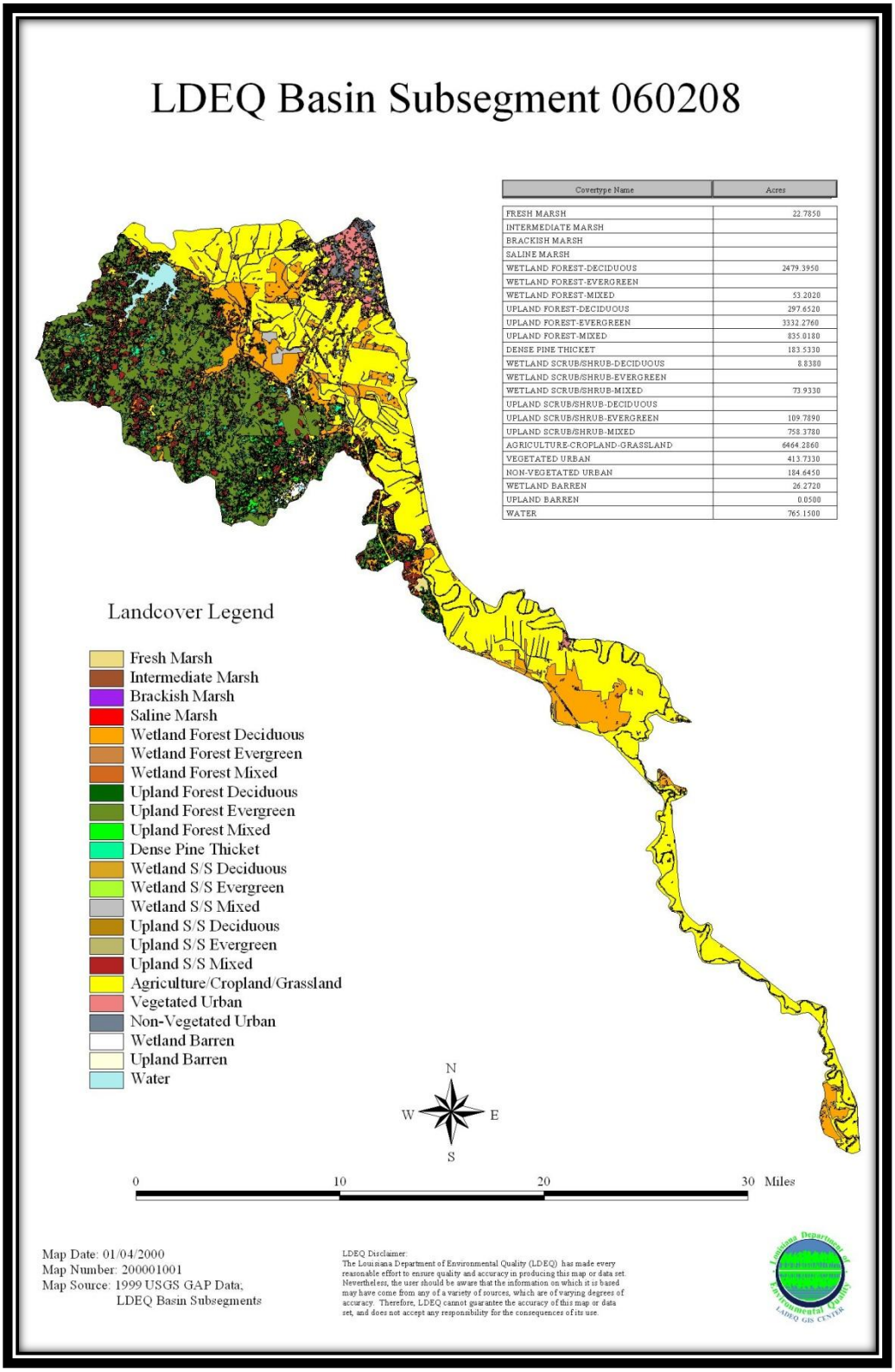
The The Vermilion-Teche River Basin lies in south-central Louisiana. The upper end of the basin lies in the central part of the state near Alexandria, and the basin extends southward to the Gulf of Mexico. The basin is bordered on the north and northeast by a low escarpment and the lower end of the Red River Basin. The Atchafalaya River Basin is to the east, and the Mermentau River Basin is to the west (LA DEQ, 1996).

The Vermilion-Teche basin's drainage area covers approximately 4,047 square miles. Habitats within the basin range from the upland pine forests, northwest of Alexandria, to agriculture lands consisting primarily of corn and soybeans, in its northern portion, and rice and sugarcane in its central and southern portion. The coastal zone is mostly freshwater marsh from Bayou Cypremort east to LA Hwy 317. Intermediate and brackish marsh occupies the entire coastal zone west of Bayou Cypremort with small areas of salt marsh on Marsh Island WMA and Paul J. Rainey Wildlife Sanctuary.

Map of Vermilion-Tech Basin



2.0 WATERSHED LAND USE



Covertype Name	Acres
FRESH MARSH	22.7850
INTERMEDIATE MARSH	
BRACKISH MARSH	
SALINE MARSH	
WETLAND FOREST-DECIDUOUS	2479.3950
WETLAND FOREST-EVERGREEN	
WETLAND FOREST-MIXED	53.2020
UPLAND FOREST-DECIDUOUS	297.6520
UPLAND FOREST-EVERGREEN	3332.2760
UPLAND FOREST-MIXED	835.0180
DENSE PINE THICKET	183.5330
WETLAND SCRUB/SHRUB-DECIDUOUS	8.8380
WETLAND SCRUB/SHRUB-EVERGREEN	
WETLAND SCRUB/SHRUB-MIXED	73.9330
UPLAND SCRUB/SHRUB-DECIDUOUS	
UPLAND SCRUB/SHRUB-EVERGREEN	109.7890
UPLAND SCRUB/SHRUB-MIXED	758.3780
AGRICULTURE-CROPLAND-GRASSLAND	6464.2860
VEGETATED URBAN	413.7330
NON-VEGETATED URBAN	184.6450
WETLAND BARREN	26.2720
UPLAND BARREN	0.0500
WATER	765.1500

2.1. Bayou Boeuf Watershed Description

Bayou Boeuf originates near Kincaid Reservoir, west of Alexandria, Louisiana. The subsegment is mostly agriculture and forest with some urbanized areas. Bayou Boeuf flood plain is historically in the bottomlands of the Red River and was formerly a channel. Today, the Red River is leveed and cut off from Bayou Boeuf. Bayou Boeuf flows through Rapides, Avoyelles, and St. Landr y Parishes.

Although the watershed is predominately flat, its headwaters are located in an area of low hills, adjacent to the Kisatchie National Forest. Near its headwaters, elevations of the waterway are around 85 feet (with nearby Kisatchie National Forest peaks as high as 180 feet). As Bayou Boeuf flows southeasterly, it loses elevation before finally ending at its confluence with Bayou Cocodrie. Bayous Cocodrie and Boeuf join to form the headwaters of Bayou Courtableau at an elevation of about 30 feet, just northeast of the town of Washington. Elevations of the bayou are extremely flat as it flows for over 100 miles, through forests, agriculture lands and the towns of Cheneyville and Lecompte, before its end.

2.2. Field Survey of Bayou Boeuf Watershed

On November 19, 2008 and December 22, 2008 LDEQ Nonpoint Unit staff visited the Bayou Boeuf watershed. The bayou flows through a scenic part of the state, originating southwest of Alexandria, Louisiana near Kincaid Reservoir. Sweeping agriculture fields extend as far as the eye can see in much of the subsegment. There are some urbanized areas south of Alexandria and east of Fort Polk on LA 28. (Fort Polk is not part of the subsegment.) Mature forests stand in the northern part of subsegment 060208. Bayou Boeuf has been hydromodified at many places so that water quality improvements may be limited in that regard.

Figure 1 Headwaters of Bayou Beouf outside of Kincaid Rsevoir

Figure 2 Another view of the headwaters with some minor blockage from debris

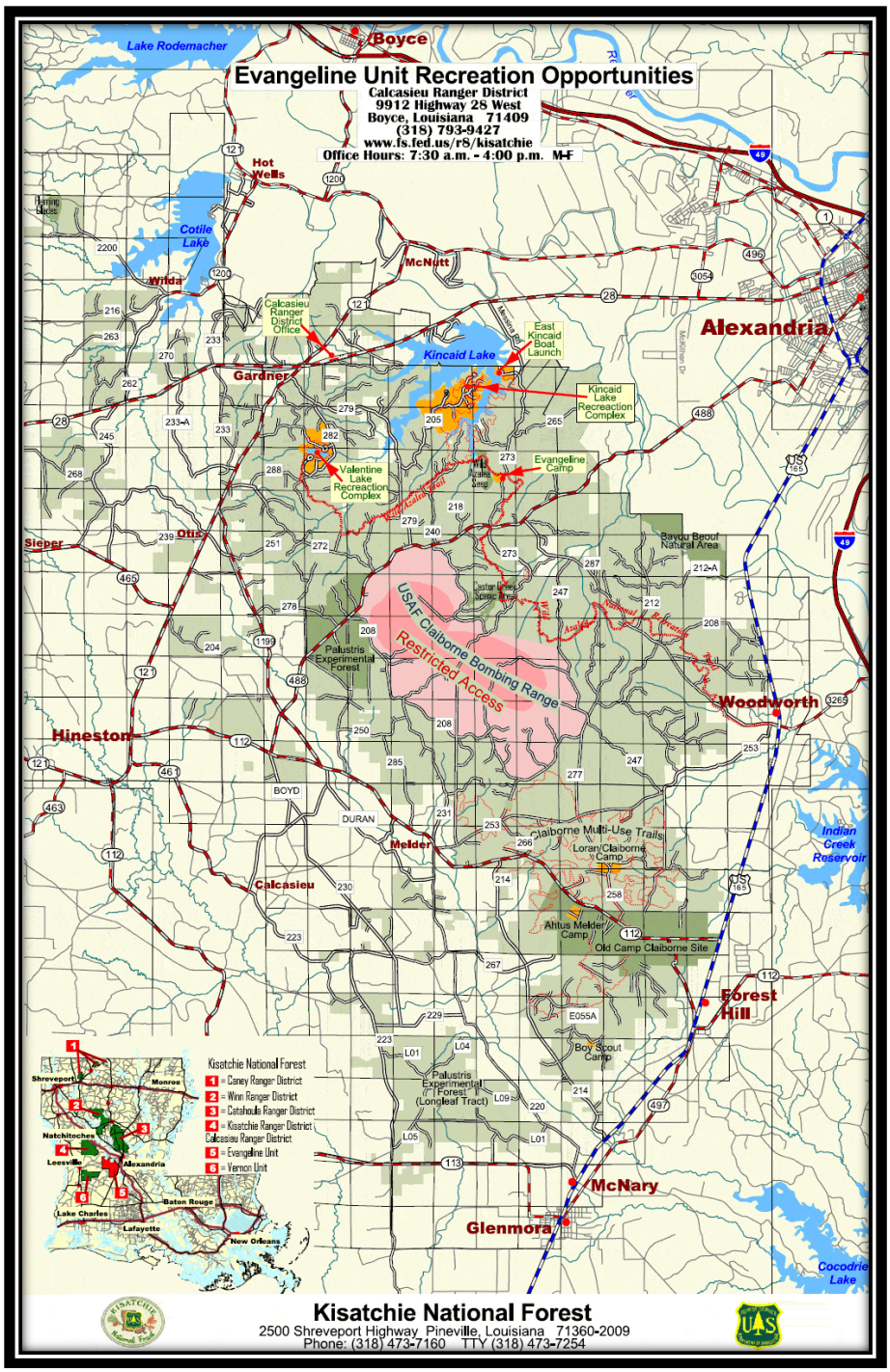
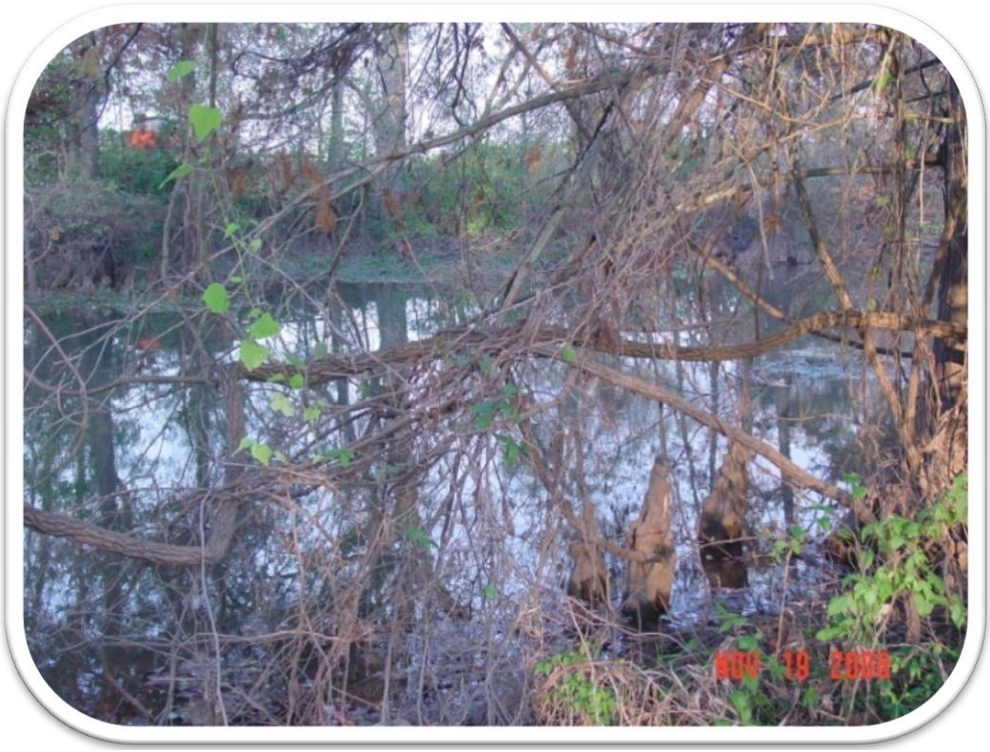
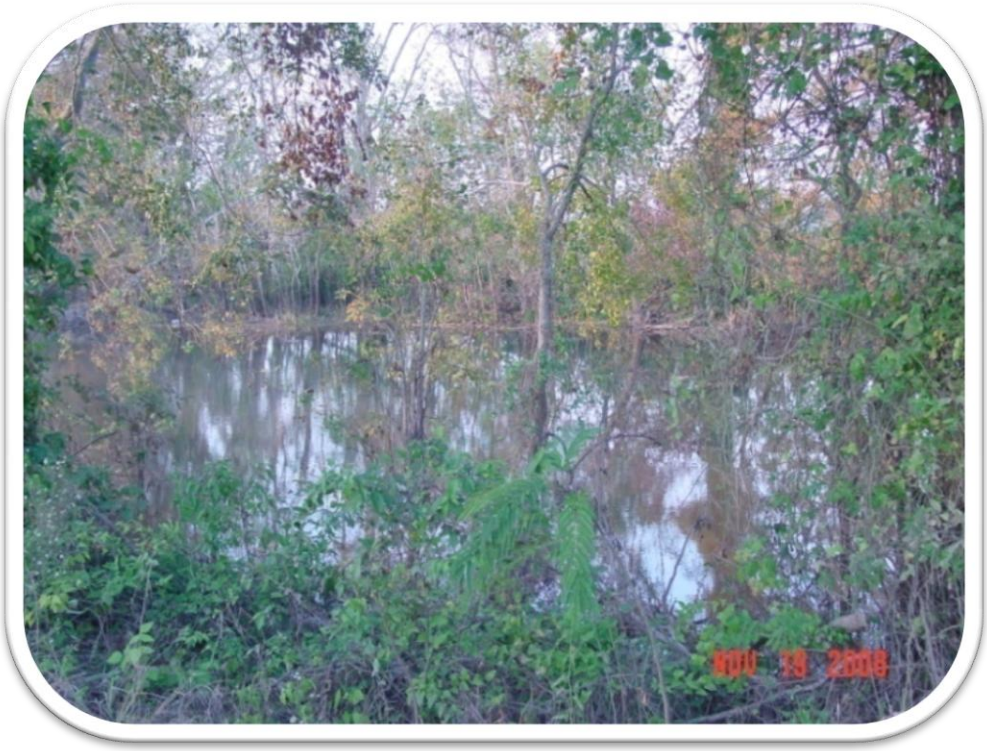


Figure 3 Evangeline Unit Recreation Opportunities. Large tracts of forest land are still found in the subsegment, including a portion of the Evangeline Unit of the Kisatchie National Forest. The area around, and southeast of, Kincaid Lake lies in the northern portion of Bayou Boeuf subsegment.





Figures 4 and 5 In Cheneyville, the Bayou flows alongside LA 71 through extensive swaths of agriculture fields. There is an established buffer in much of this extent.

From the field survey, it was not apparent that agriculture runoff flows excessively into Bayou Boeuf. While it is likely that some runoff may reach the bayou, it appeared that agriculture BMPs were being implemented throughout the subsegment. There were some established riparian buffers throughout most of the agriculture lands. Some of these are wider than others, but usually there was some natural buffer present. Also, the cultivated fields are mostly located in areas of relatively lower elevations and might tend to naturally flow away from the waterway. There was no agriculture discharge observed entering Bayou Boeuf.

Figure 6 Scenic Bayou Boeuf in the town of Lecompte

3.0 WATER QUALITY ANALYSIS

Designated uses in Bayou Boeuf are primary contact recreation, secondary contact recreation and fish and wildlife propagation. Primary contact recreation (PCR) includes recreation and other uses where there is prolonged body contact such as swimming and water skiing. Secondary contact recreation (SCR) is recreation and other uses where body contact is incidental such as fishing and boating. Failure to maintain PCR and SCR indicates that fecal coliform levels may be elevated in a water body. Although the standard for Secondary Contact Recreation is being maintained, Bayou Boeuf is presently in violation of its standard for Primary Contact Recreation. Pathogen indicators have been present in the bayou for a number of years; however, the draft 2008 Integrated Report indicates that this may no longer be a problem. Upon approval of the latest Integrated Report, it may be that Bayou Boeuf attains its standard of Primary contact recreation.

Its third designated use of Fish and Wildlife Propagation remains problematic. Propagation of Fish and Wildlife refers to the protection of aquatic habitat, food, reproduction and travel corridors. A main criterion in determination of use attainment for FWP is the concentration of dissolved oxygen (D.O.). D.O. levels of 5 mg/L are the standard to support FWP. Bayou Boeuf is presently in violation of its standard for Fish and Wildlife Propagation.

Table 2 Designated Uses for the Water body subsegment 060208

Designated Use	Measured Parameter	Support Classification for Measured Parameter		
		Fully Supporting	Partially	Not Supporting
Primary Contact Recreation (PCR)	Fecal coliform[1]	0-25% do not meet criteria	-	>25% do not meet criteria
	Temperature	0-30% do not meet criteria	>30-75% do not meet criteria	>75% do not meet criteria
Secondary Contact Recreation (SCR)	Fecal coliform[1]	0-25% do not meet criteria	-	>25 % do not meet criteria
Fish and Wildlife Propagation (FWP)	Dissolved oxygen[2]	0-10% do not meet minimum of 3.0 ppm and median > criteria of 5.0 ppm	-	>10% do not meet minimum of 3.0 ppm or median < criteria of 5.0 ppm
	Dissolved oxygen[3]	0-10% do not meet criteria	>10-25% do not meet criteria	>25% do not meet criteria
	Temperature, pH, chloride, sulfate, TDS	0-30% do not meet criteria	>30-75% do not meet criteria	>75% do not meet criteria

1. For Bayou Boeuf, criteria are as follows: PCR, 400 colonies/100 mL; SCR, 2,000 colonies/100 mL
2. Water bodies without a special study to establish specific criteria for D.O.
3. Water bodies for which a special study has been conducted to establish criteria for D.O.

Table 3 Numerical Criteria	
Subsegment Number	060208
Water body Description	Bayou Boeuf – from headwaters to Bayou Courtableau
Designated Uses	A, B, C
Criteria:	
Chlorides	45 mg/L
Sulfates	35 mg/L
DO	5.0 mg/L
pH	6.5 – 8.5
Temperature	32 °C
TDS	100 mg/L
A- primary contact recreation; B- secondary contact recreation; C- propagation of fish and wildlife	

3.1. Water Quality Test Results

There are two monitoring stations on Bayou Boeuf that provide ambient water quality data to LDEQ. These are Station 0104 near Milburn, Louisiana and Station 0668 north of Washington, Louisiana. Station 0104 is located in the southern part of the subsegment in an area of agriculture, forestry, and some urban development. For 0104 in Milburn, data are available for the twenty-one years 1978 through 1998. Not all water quality parameters were sampled in all years.

Station 0668 is located near the Bayou Boeuf outlet, where it joins Bayou Cocodrie and subsequently empties into Bayou Courtableau at its end. Ambient data are available for 1998, 2003, and 2005, although not all parameters were sampled in all three years. Data collection on 0668 resumed in October 2008 and will continue until September 2009.

Figures 7 and 8 Bayou Cocodrie (water covered by dense vegetation) approaches Bayou Boeuf from the north in photo on left. Bayou Boeuf is shown, at its junction with Bayou Cocodrie, in photo on right. Confluence with Bayou Cocodrie is on the right of photo under overhanging branches.

Dissolved Oxygen

As the following tables show, Bayou Boeuf frequently falls below its dissolved oxygen standard of 5.0 mg/L during the months of April to September.

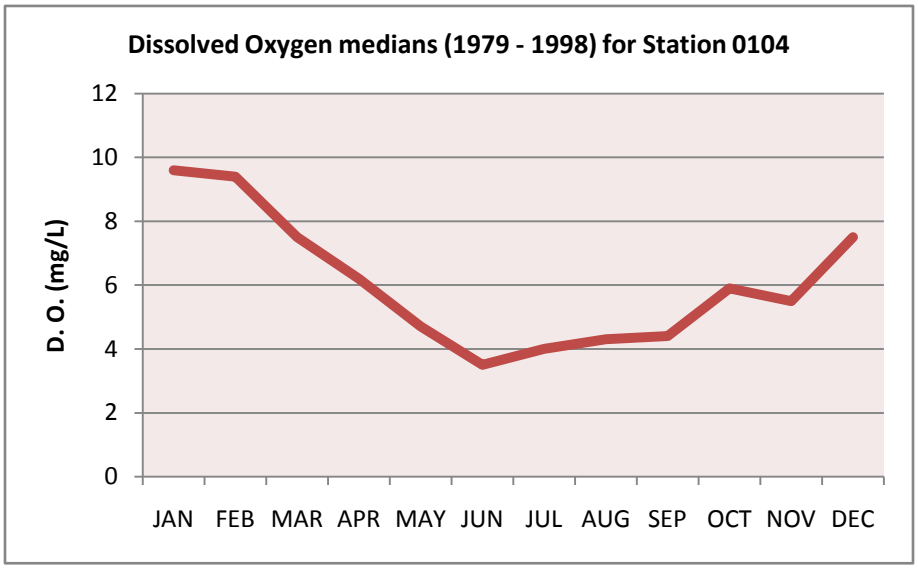


Figure 9 Dissolved oxygen medians by month for station 0104

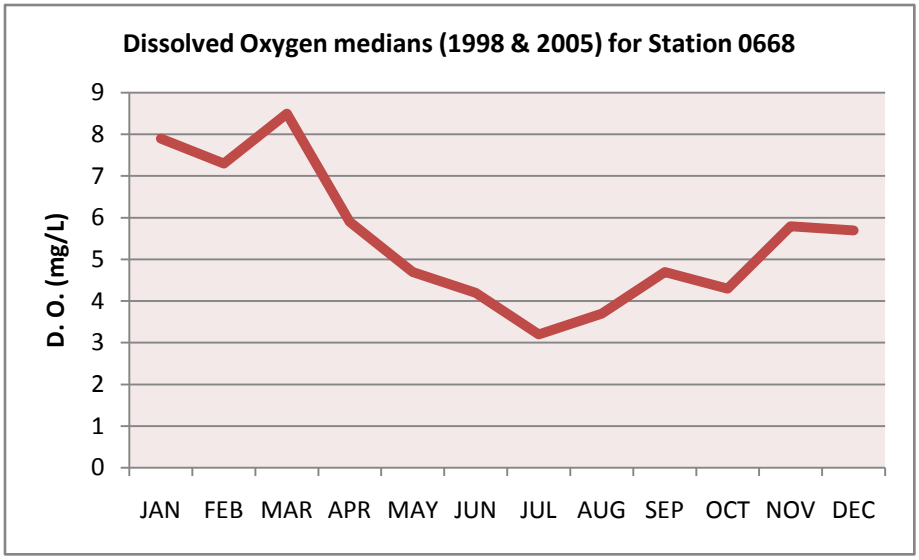


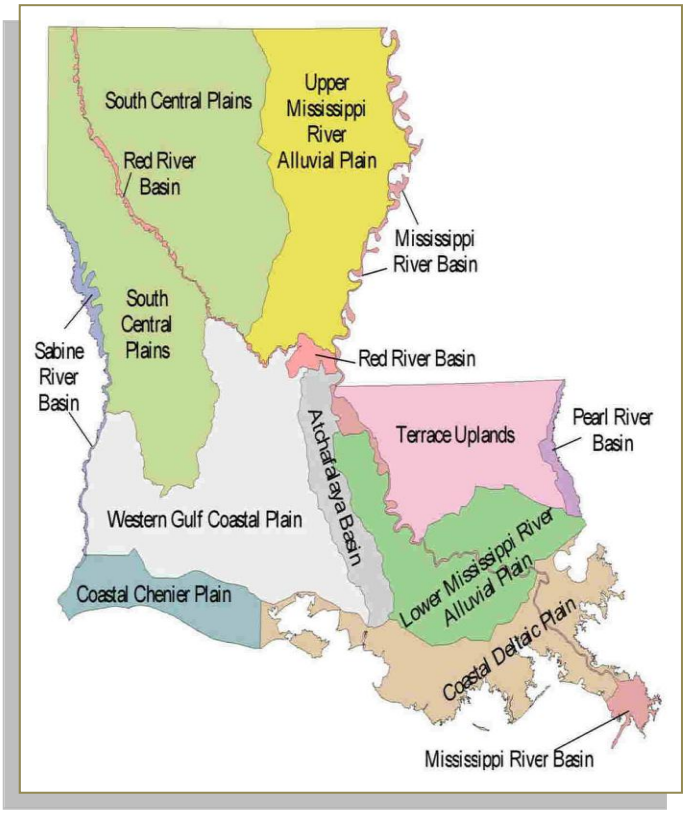
Figure 10 Dissolved oxygen medians by month for station 0668

Table 4 Median DO values by year for Bayou Boeuf

Year	Median D.O. (mg/L)
For Station 0104	
1978	5.5
1979	4.7
1980	6.2
1981	5.3
1982	5.6
1983	6.0
1984	5.8
1985	4.4
1986	4.4
1987	5.0
1988	5.4
1989	6.2
1990	4.8
1991	5.7
1992	6.0
1993	6.3
1994	5.8
1995	6.3
1996	5.8
1997	5.5
1998	4.4
For Station 0668	
1998	4.4
2005	4.6

Nutrients

At present there are no specific numeric criteria for nutrients in Louisiana. However, the State currently has a narrative standard that states "The naturally occurring range of nitrogen-phosphorus ratios shall be maintained…Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters."



Louisiana has implemented an ecoregional framework to assess water quality and ecological conditions in least-disturbed streams (LDEQ web site). These least-disturbed streams are used as reference streams to assess other, similar water bodies in the same ecoregion. Ecoregions denote areas of similar ecological characteristics.

Bayou Boeuf is located in the Western Gulf Coastal Plain Ecoregion. The Western Gulf Coastal Plain has relatively flat topography and was historically grasslands. A high percentage of the land is in cropland. Rice, grain sorghum, cotton, and soybeans are principal crops grown. Urban and industrial land uses have expanded in some parts of the region, and oil and gas production is common.

Figure 11 Louisiana Ecoregions

LDEQ has established median nutrient values for Total Nitrogen and Total Phosphorus in the Western Gulf Coastal Plain. These are 0.184 mg/L for Total Phosphorus and 1.29 mg/L for Total Nitrogen. From looking at the most recent data from Station 0668 near the end of Bayou Boeuf, it is apparent that nitrogen may not be a major concern while phosphorus does show exceedances.

Table 5 Nitrogen and Phosphorus medians for three years in Bayou Boeuf				
Station 0668				
YEAR	NO3 + NO2 (ppm)	TKN (ppm)	NO3 + NO2 plus TKN (ppm)	PHOSPHORUS (AS P) (ppm)
1998	0.16	0.93	1.09	0.20
2003	0.19	1.1	1.29	0.26
2005	0.13	0.78	0.91	0.27

Total Dissolved Solids

TDS represents the concentration of dissolved substances in water. It may be comprised of salts as well as some organic matter. It may be seen that TDS levels are high and routinely exceed the Bayou Boeuf standard of 100 mg/L. (mg/L is used interchangeably with ppm. The two measures are considered equivalent.)

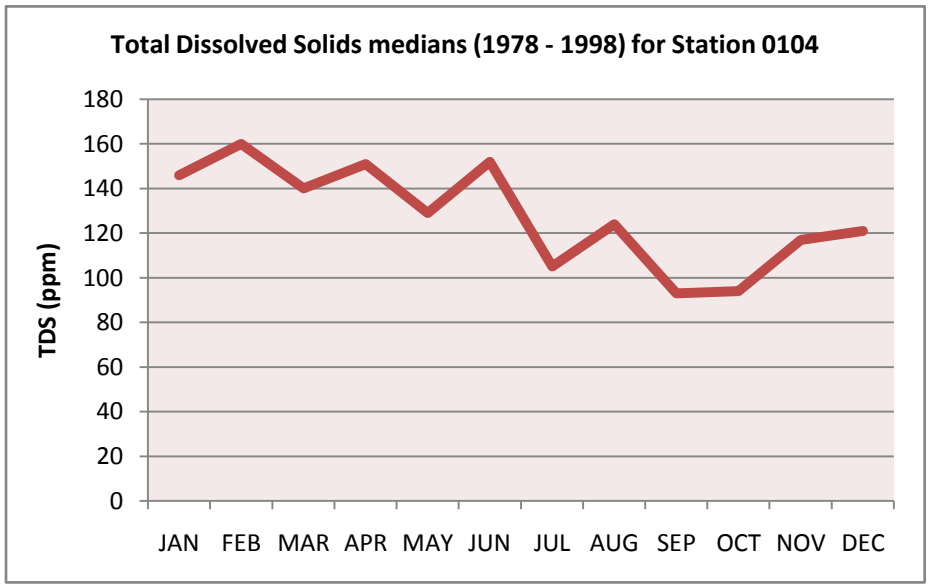


Figure 12 TDS medians by month for station 0104

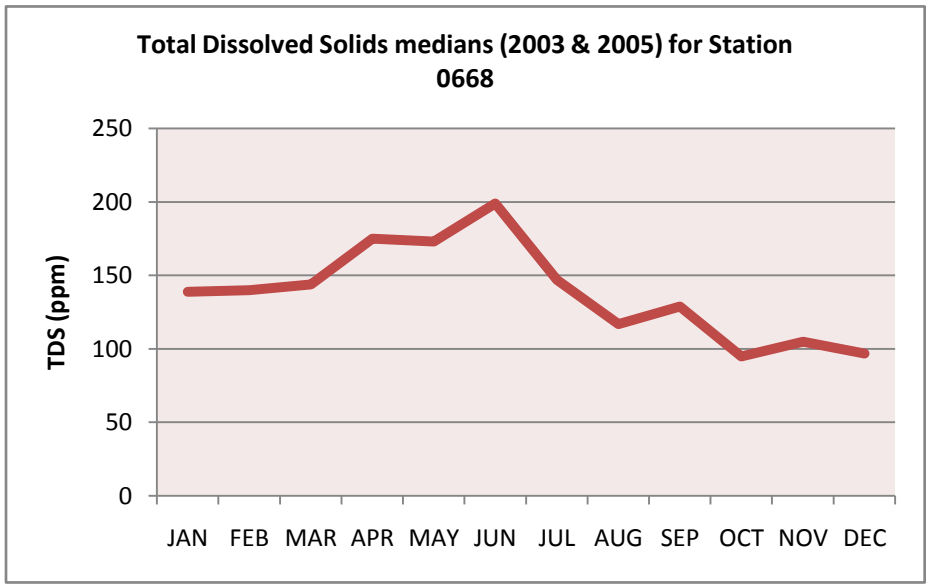


Figure 13 TDS medians by month for station 0668

Table 6 Median TDS values by year for Bayou Boeuf

Year	Median TDS (ppm)
For Station 0104	
1978	109
1980	92
1981	117
1982	123
1983	112
1984	118
1985	132
1986	124
1987	114
1988	135
1989	124
1990	164
1991	159
1992	157
1993	187
1994	146
1995	175
1996	130
1997	184
For Station 0668	
2003	136
2005	147

Bacteria

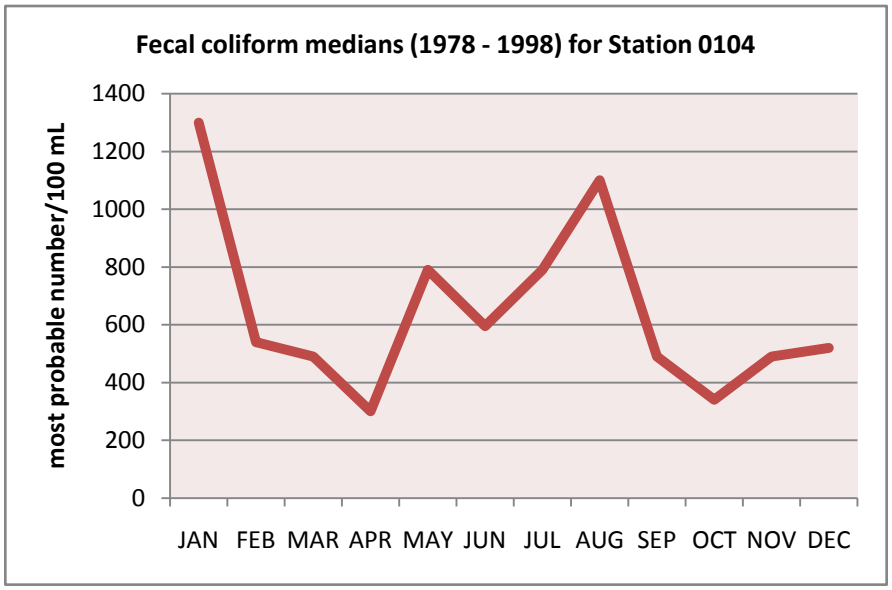


Figure 14 Fecal coliform medians by month for station 0104

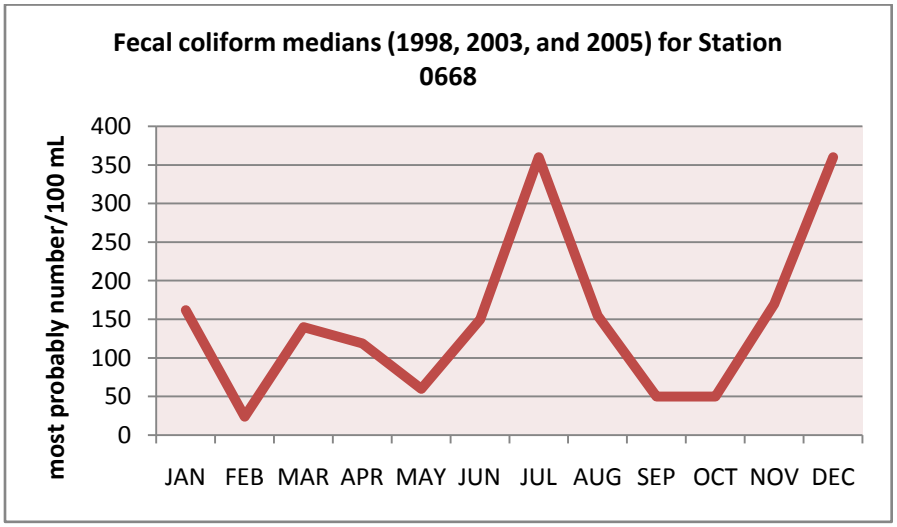


Figure 15 Fecal coliform medians by month for station 0668

Table 7 Median Fecal coliform values by year for Bayou Boeuf

Year	Median Fecal Coliform (MPN/100 mL)
For Station 0104	
1978	540
1979	230
1980	790
1981	410
1982	230
1983	665
1984	240
1985	330
1986	1250
1987	4450
1988	2400
1989	8000
1990	1400
1991	550
1992	155
1993	400
1994	400
1995	400
1996	135
1997	550
1998	265
For Station 0668	
1998	130
2003	49
2005	190

Fecal coliform refers to a group of bacteria that is associated with the intestines of warm- blooded animals. It is generally monitored as an indicator of potential human health threats resulting from swimming. Testing for fecal contamination is one way to determine the presence of human and/or animal waste in a water body. Although the bacteria itself does not cause disease, a positive finding may indicate the presence of other pathogenic organisms that are harder to detect. Nonpoint sources of fecal contamination include wildlife, grazing livestock, land application of manure, pets, and failed septic systems. Louisiana has established a seasonal water quality standard for bacteria based upon definition of a summer swimming season and winter secondary contact only.

4.0 TMDL FINDINGS

Total Maximum Daily Loads (TMDLs) are the maximum amount of a pollutant that can be discharged into a water body without causing the water body to become impaired and/or violate state water quality standards. TMDLs are the sum of the individual Waste Load Allocations (WLAs) for point sources, Load Allocations (LAs) for nonpoint and natural background sources, and a Margin of Safety (MOS).

TMDL Allocation = WLA + LA + MOS

There have been three TMDLs developed for Bayou Boeuf.

4.1. TMDL for Oxygen Demanding Substances

A TMDL for oxygen-demanding substances was completed by DEQ in 1999 and revised in 2000 and 2001. The TMDL was based upon survey data collected in 1986 and 1999. Although the bayou has been cited previously for nutrient impairment, nutrient load reductions were not included in the TMDL model. It is believed that the nutrient levels in the bayou are typical of natural background concentrations in Louisiana streams.

The current dissolved oxygen criterion for subsegment 060208 is 5.0 mg/l year-round. Criteria of 3.5 mg/l (June–August) and 5.0 mg/l (September–May) have been proposed. It was projected that compliance with proposed DO criteria would require reductions in point and non-point source loadings. Nonpoint load reductions were calculated for three types of land use-urban, suburban/agricultural, and agricultural. The TMDL found that "urban areas discharging to Flat Bayou, North Boeuf-Cocodrie Diversion Channel, and Bayou Robert would require an 80% reduction of non-point loading. Suburban/agricultural areas discharging to upper Bayou Boeuf, Middle and Grassy Bayous, and Bayou Clear would require a 50% reduction of non-point loading. The agricultural areas draining to Bayou Boeuf below Lecompte were not projected to require a reduction in loading. It was further projected that compliance with the existing dissolved oxygen criteria would require the elimination of all man-made non-point loading in all land use areas plus the reduction of background SOD. . . in the urban areas."

4.2. TMDL for Fecal Coliform

A TMDL for fecal coliform was completed in 2000 by LDEQ. It found that a 369% reduction in fecal coliform loading during the May – October season would be needed to protect the primary contact recreation use.

Louisiana has established a seasonal water quality standard for bacteria based upon definition of a summer swimming season (May – October) and winter secondary contact only (November – April). Bayou Boeuf is already in full compliance for its secondary contact recreation use.

Louisiana's water quality standard for protection of the primary contact recreation use reads as follows:

"No more than 25 percent of the total samples collected on a monthly … basis shall exceed a fecal coliform density of 400/100mL. This primary contact recreation criteria shall apply only during the defined recreational period of May 1 through October 31. During the non-recreational period of November 1 through April 30, the criteria for secondary contact recreation shall apply."

The TMDL for fecal coliform was calculated using data from 1994 – 1998. More recent data (depicted on previous graphs and tables in this document) indicate a reduction in fecal coliform levels. Also, LDEQ has recommended the bayou be de-listed for pathogens in its 2008 Integrated Report.

4.3. TMDL for Total Dissolved Solids

A TMDL for Total Dissolved Solids (TDS) was completed by EPA in 2003.

It was found that a 39.5% reduction in TDS loading would be needed to meet the standard for Fish and Wildlife Propagation. TDS continues to be a problem in this heavily utilized waterway and it is rare that the bayou meets its standard of 100 mg/L.

5.0 SOURCES OF NONPOINT SOURCE POLLUTION LOADING

Nonpoint source water pollution often results from many different sources in the watershed. Therefore, identifying all the types of land use, the land cover, and the distribution of each type within the watershed boundary is an important key for managing sources of NPS pollution. This type of information provides insight of where and what the sources of NPS pollutant loadings are. Land use activities such as agriculture, urban, forestry and natural systems can contribute to the pollutant loading of the waterway.

The 2006 303(d) list indicates the suspected causes and suspected sources of impairment, which are listed in Table 8. The suspected causes of impairment for Fish and Wildlife Propagation are Nitrate/Nitrite, Dissolved Oxygen, and Total Phosphorus, Sedimentation/Siltation, TDS, TSS, and Turbidity all of which have a suspected source of irrigated and non-irrigated crop production.

Table 8 2006 303(d) List of Suspected Causes and Sources

Impaired Use	Suspected Causes of Impairment	Suspected Sources of Impairment
Fish and Wildlife Propagation	Nitrate/Nitrite	Irrigated and Non-irrigated Crop Production
Fish and Wildlife Propagation	Dissolved Oxygen	Irrigated and Non-irrigated Crop Production
Fish and Wildlife Propagation	Total Phosphorus	Irrigated and Non-irrigated Crop Production
Fish and Wildlife Propagation	Sedimentation/Siltation	Irrigated and Non-irrigated Crop Production
Fish and Wildlife Propagation	Total Dissolved Solids	Irrigated and Non-irrigated Crop Production
Fish and Wildlife Propagation	Total Suspended Solids (TSS)	Irrigated and Non-irrigated Crop Production
Fish and Wildlife Propagation	Turbidity	Irrigated and Non-irrigated Crop Production

5.1. Forestry

Evergreen Forestland and Deciduous Forestland make up about 64% of the Bayou Boeuf Watershed. Most of this forestland is located to the west of the bayou. There is silviculture activity occurring in this forest. Clearing the land of trees exposes the bare soil. Erosion results in the sediment being carried away by the storm water. Improperly located, constructed and maintained roads are the biggest source of NPS pollution from forestry activities. Removing the trees too close to a stream will result in streambank erosion. Heavy equipment crossing through streams also causes erosion and increases sediment delivered directly into the water body.

Herbicides, insecticides, and fungicides are used to control forest pests and undesirable plant species, but can be toxic to aquatic organisms. Pesticides that are applied to foliage or soils, or are applied by aerial means, are most readily transported to surface and ground waters. Some pesticides with high solubility's can be extremely harmful, causing either acute or chronic effects in aquatic organisms, including reduced growth or reproduction, cancer, and organ malfunction or failure. Other "chemicals" that may be released during forestry operations include fuel, oil, and coolants used in equipment for harvesting and road-building operations.

5.2. Agriculture

Agriculture occupies the second largest area of land (40%) within the Bayou Boeuf Watershed. The primary agricultural crop is sugarcane, but also includes cotton, soybeans, rice, crawfish, and corn. Nutrient, pesticide, and sediment loading are associated with these activities.

It is suspected that the amount of nitrogen and phosphorus entering the water body may start to decline in the future. Since the price of fertilizer has more than quadrupled from 2006 to 2008, farmers are applying less fertilizer to their land or none at all. As a result, there should be less nutrients in the runoff coming from the watershed in the future.

5.2.1. Row Crops

The majority of the watershed is used for growing row crops. The common practice for preparing row crops is soil tillage. Erodible soils that have a "K-factor" (soil erodibility factor) greater than 0.4 are more susceptible to erosion when tilled or devoid of vegetation. When rainfall occurs, the soil can be easily washed into the receiving stream. This sediment runoff is often laden with fertilizers, pesticides and herbicides that can result in NPS pollutant loading into the river. If the flow rate in Bayou Boeuf is low, the NPS load can deposit and accumulate on the stream bottom. As the seasons progress, warm temperatures increase the rate at which these pollutants degrade, consuming the D.O. in the receiving stream.

When fields are cultivated all the way to the edge of a stream or drainage way, there is no buffer or filtration zone for the runoff coming off the fields. Herbicides are the most common form of weed control and may be utilized as much as five times per year. They are used for weed control in the fields, along the edges of the fields, and drainage ditches. The edge of fields and drainage ways are usually kept "barren" offering almost no conservation of nutrients and soil. The bare stream banks and canals or ditches can result in increased erosion to the bayou.

Figures 16 and 17 Row Crops in Bayou Beouf Watershed

5.2.2. Pastureland

Pastureland makes up only a small portion of the agricultural production in this watershed. Pastures require large inputs of fertilizers in order to keep a healthy food supply for the grazing animals and the production of hay. Excessive fertilizer, untimely applications, and applications near the waterways increase the probability of these nutrients getting washed into the bayou. When cattle are allowed continuous access to the stream banks, it increases the rate of bank erosion and deposition of fecal material near the stream. Cattle are attracted to these areas because of shade, water supply, and lush vegetation. Areas having high numbers of cattle that are located near a tributary or drainage are likely to contribute a significant NPS load that can affect the dissolved oxygen, fecal coliform, and nutrients in the river.

Figure 18 Pastureland in Bayou Beouf Watershed

6.0 NONPOINT SOURCE POLLUTION SOLUTIONS

Implementation of best management practices in the watershed constitutes the building blocks of watershed protection and improving water quality. Since the watershed encompasses a narrow range of land uses, the description of BMPs is divided into categories. Each different category contains site-specific BMPs that minimize a particular source of NPS pollution. BMPs can include structural controls and/or nonstructural controls. Structural controls are those, whether natural or man-made, that can filter, detain, or reroute contaminants carried in surface runoff. Nonstructural controls utilize techniques such as land-use planning, land-use regulations, and land ownership to eliminate or minimize sources generating NPS loading. Some of the most important aspects of successfully implementing BMPs are public awareness, education, and participation. Reduction and prevention of NPS pollution in the watershed will involve a concerted effort from all the stakeholders in it.

6.1. Forestry BMPs

Forestry BMPs are designed primarily to reduce the amount of sediment runoff from forestry operation sites to local bodies of water. In order to minimize the impacts of potential NPS pollutant loads into bodies of water in Bayou Pierre and to sustain future timber harvests, operators should employ management practices that restrict timber harvest from wet areas and utilize select-cut timber harvesting practices. This approach will help maintain the important functions of the forest within the watershed while also sustaining future timber harvests.

The areas of land located along a body of water or stream bank is referred to as the riparian buffer zone, the transitional area between land and water. A riparian zone consists of land adjacent to and including a stream, river, and or other area that is at least periodically influenced by flooding in a natural state. Similar to vegetated filter strips, native plants in the riparian area effectively prevent sediment, chemicals, and organic matter from entering bodies of water. Restricting timber harvest from these areas is a BMP that forestry operations can implement, which can significantly control NPS loads from the site and protect water quality. Unlike filter strips, riparian zones are composed of higher order plants, such as trees and shrubs, as well as grasses, legumes, and wetland plants. Vegetated filter strips can be used in conjunction with riparian areas as an initial filtering component for sediment runoff from a timber site.

Other practices that can be implemented to reduce both direct and indirect NPS loads are “select cut techniques” and “no tree felling within wet areas”. Utilizing select cut techniques helps maintain sustainable forestry operations without impairing its functions in the local environment. A comprehensive list of forestry BMPs with explanation and illustrations of forestry practices is found in the *Louisiana’s Forestry BMP Manual*.

Effective implementation of BMPs will require programs that provide technical information, facts, and incentives for helping foresters. These programs should be designed to create awareness and participation in BMP implementation. LDEQ

continues to work cooperatively with all the local and state forest entities to provide statewide forestry educational programs. A list of program activities for forestry is included in the *Louisiana's Nonpoint Source Management Plan, 2000*.

6.2. Agriculture BMPs

Agricultural BMPs are generally associated with the management of soil, nutrients, pesticides, and water, which are known to be a contributing source of NPS pollutant loading. If fertilizers, herbicides, and pesticides remained in the fields, the NPS load would be less. Therefore, sites should be managed in such a way that the surface runoff rate is not excessive and that it is not contaminated. Reducing NPS loading from agricultural fields will require a concerted effort between all the associated federal, state, and local agencies. Proper management will require agriculture programs which provide environmental education as well as effective production strategies. Agriculture programs should be designed to foster a sense of conservation stewardship for each type of agricultural producer. Examples of these programs are the Louisiana Master Logger Program and the Louisiana Master Farmer Program.

For successful agricultural programs to continue in the watershed, all the cooperating entities will need to participate. The key partners (i.e. NRCS, SWCD, LDAF, LCES, LDNR, and FSA) are the federal, state, and local agencies, which provide funding through cost-share assistance, incentives, expertise through technical assistance, and education through information outreach programs to the farmers. A complete list of agriculture BMPs is provided by the NRCS in the "Technical Guide Handbook". The handbook includes a description of each BMP and their recommended uses. LDEQ has a comprehensive list of BMPs for controlling NPS pollutant loads, programmatic goals and activities, and future objectives and milestones included in the State of Louisiana Water Quality Management Plan, Volume 6, Louisiana's Nonpoint Source Management, 2000.

6.2.1. Row Crop BMPs

Row crops occupy the vast majority of agricultural land use in the watershed. Implementation of row crop BMPs may help reduce a significant amount of the NPS loading because many of the crops are located near the banks of Bayou Boeuf.
Row crop agriculture involves tillage practices that pulverize the soil in order to create a heaping row for planting crops. BMPs for this type of land use should be focused on the management of soil, water, pesticides, and nutrients. These constituents are known to cause NPS pollutant loads, if they are washed into the receiving stream by surface runoff. Controlling the NPS pollutant loading requires implementing BMPs that reduce the amount of surface runoff and the amount of NPS pollutants in it. In addition to implementing BMPs, the producer should develop and utilize pollution prevention strategies such as spill prevention practices for sites

where the agro chemicals and fertilizer are stored, off loaded, or prepared for field application.

Conservation Tillage

Conservation tillage practices such as stale seed bed and no till have proven to be successful in producing less NPS loading. These practices utilize bulk organic matter remaining from winter crops as a sponge, while planting directly into it. Leaving bulk material in the fields after harvest is known as residue management, which has a positive effect on surface water quality. Planting soybeans directly into the soil without tillage is another conservation practice. Conservation tillages are designed to reduce the amounts of runoff and rates of flow. In return, there is more sediment, nutrients, and pesticides/herbicides remaining in the fields for growth each growing season. This saves money and reduces the NPS loading.

LDEQ funded a project in the Bayou Wikoff sub-watershed of Bayou Plaquemine Brule in the Mermentau Basin. The purpose of this project was to gather information on the effectiveness of best management practices in reducing nonpoint source pollutants from sugarcane fields. The results indicated that when mulch residue was left on the field after harvest, that total solids could be reduced by 34%, suspended solids by 26%, turbidity by 60% and phosphorus by 8% compared to fields where the sugarcane residue was burned. Therefore, leaving the mulch on the field after harvest will reduce the amount of nonpoint source loadings into the bayou.

Vegetated Filter Strip

A general and cost effective practice is to maintain a strip of vegetation around the perimeter of each field site and within the field ditches. This practice is similar to the BMP referred to as vegetative filter strip or field border and the grassed waterway, except use of native vegetation for cover is encouraged. If the grassed waterway is covered with wetland plants and/or native grasses, the drainage way can also function as a form of passive biological treatment, which can also reduce NPS loads. The amount of herbicides used should be less, saving costs.

Field sites having a high population density should consider field-rotations to allow for re-establishment of vegetation cover and maintenance. Sites with a healthy cover of vegetation have less runoff. If a field site's size is not adequate for field-rotations, ponds could be constructed to capture excess surface runoff from the site. The surface runoff could be routed through a vegetated field ditch, which would work in conjunction with the pond to reduce NPS loading from leaving the site. These practices help to keep the sediment, nutrients, and fecal coliform at the field site.

The land in and along field ditches, wetlands, and stream banks is very important for preventing sediment, nutrients, and organic matter from entering bodies of water. This area of land between wet and upland landscapes is referred to as the riparian buffer zone. Protecting these areas from continuous livestock grazing is an effective BMP for preventing NPS pollutant loading. Often livestock access these areas for a source of water, shade, and lush vegetation. When livestock are restricted from the riparian buffer zone, the producer should make accommodations to provide an alternative source of water, shade, and food.

Optical Sensors

Recent technological advances in agriculture have enabled the use of optical sensors, which allow varying amounts of fertilizer to be applied to crops instead of one set amount for the entire field. Optical sensors can be mounted on tractors or other fertilizer application systems to deliver precise amounts of fertilizer to plants. By using infrared and near infrared light to assess the health of the crops, an optical sensor can instantly calculate the amount of fertilizer needed to obtain a maximum yield of crop. Since healthy plants absorb more infrared light during photosynthesis and reflect more near infrared light than unhealthy plants, the optical sensors can determine which plants need more fertilizer.

By using these sensors, the over-application of fertilizer can be drastically cut back and less fertilizer will be wasted. It also works equally well at night, when there is less wind drift. In addition to saving money, there will be less fertilizer available in the field to make its way into the runoff. It can also be used to apply herbicide to living weeds, and not waste spray on bare ground or dead weeds.

Precision Land Leveling

Precision land leveling involves cutting or filling a field in order to create a constant slope between 0 to 0.2%. Global positioning systems (GPS) and/or laser-guided instruments are used to create the desired slope. A levee is constructed around the field so that the desired amount of water on the field can be maintained. By keeping the field flooded until ready for planting, there is an increase in nutrient availability and weed control. The water release is controlled while the fields are drained, thus decreasing sediment loading.

All of the BMPs mentioned above are very cost effective and prevent NPS loading. In addition to implementing BMPs, the producer should develop and utilize pollution prevention strategies such as spill prevention practices for sites where the agro chemicals and fertilizer are stored, off loaded, or prepared for field application.

Field Stripcropping

Field stripcropping is the practice of growing crops in a systematic arrangement of strips. The crops are arranged so that a strip of grass or small grains is alternated with a strip of row crops. The strips should be approximately the same width. The strips of grass slow runoff, increase the infiltration of water into the soil, and trap sediment moving from the crop strips.

The United States Department of Agriculture (USDA) has assessed the effectiveness of the following measures in addressing potential water quality problems stemming from agriculture fields.

Table 9 Sediment Concerns in Surface Water - CROPLAND BEST MANAGEMENT PRACTICES [1]

PROBLEM: Sediment in a water body can smother organisms, interfere with photosynthesis by reducing light penetration, and may fill in waterways, hindering navigation and increasing flooding. Sediment particles often carry nutrients, pesticides, and other organic compounds into water bodies. Sediments can be resuspended in a water column and act as an uncontrolled source of pollution.			
PROCESSES: Soil movement in water.			
CAUSES: Precipitation on unprotected soil, flowing runoff water, and irrigation water applied at erosive rates.			
Favorable BMPs [2]	**Effectiveness of Favorable BMPs**	**Crops[3]**	**Practices which may be unfavorable[4]**
Mulch Till	Slight	1, 2, 4-6	Land clearing
No Till	Moderate	1, 2, 4-6	Clearing & snagging
Ridge Till	Slight/moderate	1, 3, 5, 6	Access roads
Contour farming	Moderate	1, 2, 5, 6	
Grassed waterway	Slight/moderate	1 – 6	
Residue mgt., seasonal	Slight	1 – 6	
Grade stab. Strut.	Slight/moderate	1 – 6	
Cons. Crop. Rot.	Slight/moderate	1 – 6	
Irrig. Water mgt. [5]	Moderate	1 – 6	
Tailwater rec. [5]	Slight	1 – 6	
Struct. Water cont.	Slight	1 – 6	
Water & sed. basin	Moderate/substantial	1, 2, 5, 6	
Sediment basin	Substantial	1, 2, 5, 6	
Irrig. Leveling [5]	Slight	1-6	
Field border	Slight/moderate	1, 2, 5, 6[6]	
Cover crop	Slight/moderate	1-6	
Deep tillage	Slight/moderate	1-6	
Filter strips/buffers	Substantial	1, 2, 4-6[6]	
Diversion	Medium	1, 2, 5, 6	

[1] There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed. [2] This list is not ranked in an order, which would indicate preference in installation. [3] 1 = cotton, 2 = soybeans, 3 = sugarcane, 4 = rice, 5 = corn, 6 = truck crops. [4] An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed. [5] Irrigated fields. [6] Fields not artificially drained.

Table 10 Nutrient Concerns in Surface Water - CROPLAND BEST MANAGEMENT PRACTICES [1]

PROBLEM: Excess nitrogen and phosphorus in a water body causes excessive plant and alga growth, an imbalance of natural nutrient cycles, and a decline in the number of desirable fish species. High nitrate levels can be hazardous to warm-blooded animals under conditions that are favorable to reduction to nitrite.

PROCESSES: Runoff of soluble nitrogen and phosphorus in water and movement of nitrogen and phosphorus combined with soil and organic matter from site.

CAUSES: Excess amounts of surface-applied nitrogen and phosphorus, runoff water and interflow, improperly managed irrigation systems, and erosion of soil and organic wastes.

Favorable BMPs[2]	Effectiveness of Favorable BMPs for: Soluble N./Adsorbed N.	Crops[3]	Practices which may be Unfavorable[4]
Nutrient Management	Substantial	1-6	Land clearing
Waste utilization	Slight/moderate	1-6	Surface drainage[6]
Irrig. Water mgt. [5]	Slight/substantial	1-6	Subsurface drain[6]
Tailwater rec. [5]	Slight/moderate	1-6	
Land leveling [5]	Slight/moderate	1-6	
Irrig. System [5]	Slight/substantial	1-6	
Field border	Slight/moderate	1-6[8]	
Cover crop	Slight/moderate	1-6	
Deep tillage	Slight/substantial	1-6	
Cons. Crop. Rot.	Slight/moderate	1-6	
Mulch till	Slight/moderate	1, 2, 4–6	
No till	Slight/slight	1, 2, 4–6	
Ridge till	Slight/slight	1-6	
Crop residue, seasonal	Slight/slight	1-6	
Water & sed. basin	Slight/moderate	1, 2, 5, 6	
Terrace	Slight/moderate	1, 2, 5, 6	
Sediment basin	Substantial	1, 2, 5, 6	
Filter strips/buffers	Substantial	1-6[8]	
Contour farming	Slight/substantial	1, 2, 5, 6	
Stripcropping	Slight/substantial	1, 2, 5, 6	
Grassed waterway	Slight/moderate	1-6[7]	

[1] There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed. [2] This list is not ranked in an order, which would indicate preference in installation. [3] 1 = cotton, 2 = soybeans, 3 = sugarcane, 4 = rice, 5 = corn, 6 = truck crops. [4] An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed. [5] Irrigated fields. [6] Where water table control or regulating water in drainage systems is not applied. [7] Chemical maintenance of vegetation may adversely affect the quality of runoff water. [8] Fields not artificially drained. [9] Where drainage practices already exist.

Table 11 Organic Matter & Bacteria Concerns in Surface Water - CROPLAND BEST MANAGEMENT PRACTICES [(1)]

PROBLEM: Animal waste and crop debris is the major organic pollutant resulting from agricultural activities. They place an oxygen demand on receiving waters during decomposition, which can result in stress or the death of fish and other aquatic species. Certain bacteria can cause disease in humans such as infectious hepatitis, typhoid fever, dysentery, and other forms of diarrhea.

PROCESSES: Movement of organic waste, bacteria, and organic matter in soil from the site and excess irrigation water.

CAUSES: Over-application of waste or irrigation water, application of waste on unsuitable sites, improper timing of waste or irrigation application, and storm runoff.

Favorable BMPs[(2)]	Effectiveness of Favorable BMPs for: Oxy Demand/Bacteria	Crops[(3)]	Practices which may be unfavorable[(4)]
Diversion	Neutral/slight	1,2,5,6	Land clearing
Waste utilization	Slight/neutral	1-6	Surface drainage[(6)]
Deep tillage	Slight/slight	1-6	Subsurface drain[(6)]
Field border	Mod/slight	1,2,5,6[(7)]	
Filter strips/buffers	Sub/slight	1,2,5,6[(7)]	
Terrace	Mod/moderate	1,2,5,6	
Contour farming	Mod/slight	1,2,5,6	
Stripcropping	Mod/slight	1,2,5,6	
Water & sed. Basin	Mod/slight	1,2,5,6	
Sediment basin	sub Mod	1,2,5,6	
Irrig water mgt[(5)]	Slight/substantial	1-6	
Irrigation system[(5)]	Slight/slight	1-6	

[(1)] There are many other practices not listed in this table which may be considered for installation for a specific purpose or as a part of a total resource management system which may increase or decrease loading or have little or no effects on water quality on a site-specific basis. An on-site analysis should be a consideration in evaluating the effect of a practice not listed. [(2)] This list is not ranked in an order, which would indicate preference in installation. [(3)] 1 = cotton, 2 = soybeans, 3 = sugarcane, 4 = rice, 5 = corn, 6 = truck crops. [(4)] An on-site evaluation should be conducted to determine if conditions exist which would result in unfavorable effects if the practice was installed. [(5)] Irrigated fields. [(6)] Where water table control or regulating water in drainage systems is not applied. [(7)] Fields not artificially drained. [(8)] Where drainage practices already exist.

6.2.2 Pastureland BMPs

Pastureland occupies a small portion of agricultural land use in the watershed. Pastureland BMPs should focus on measures to control the amount of sediment, nutrients, and fecal coliform in the surface waters draining from the field site. Knowledge of the field sites' delineation and drainage pattern can be helpful when identifying pathways and potential sources of NPS pollutants. During or shortly after a rainfall event is the best time to make this assessment. With this information, the operator can work strategically to implement the BMPs that prevent pollutant sources and/or prevent them from leaving the site.

Vegetative Filter Strip
A general and cost effective practice is to maintain a strip of vegetation around the perimeter of each field site and within the field ditches. The use of native vegetation for cover is encouraged for vegetative filter strips and grassed waterways. If the grassed waterway is covered with wetland plants and/or native grasses, the drainage way can also function as a form of passive biological treatment, which can also reduce NPS loads. The amount of herbicides used should be less, saving costs.

Prescribed Grazing
Field sites having a high population of livestock should consider field rotations to allow for the regrowth of vegetation. Sites with a healthy cover of vegetation have less runoff. If a field site's size is not adequate for field-rotations, ponds could be constructed to capture excess surface runoff from the site. The surface runoff could be routed through a vegetated field ditch, which would work in conjunction with the pond to reduce NPS loading from leaving the site. These practices help to keep the sediment, nutrients, and fecal coliform at the field site.

Riparian Buffer Zone Protection
Protecting the riparian zone along Bayou Boeuf, as well as the ditches that run into the bayou, is necessary to prevent sediment, nutrients, and organic matter from entering the bayou. Livestock frequently access these areas to obtain water, shade, and lush vegetation. The hoof traffic along the stream banks can cause serious sediment and fecal coliform loading. Fencing can be used to protect the riparian zone from the damage caused by livestock. When livestock are restricted from the riparian buffer zone, the producer should make accommodations to provide an alternative source of water, shade, and food. Water troughs should be placed on top of a concrete pad to prevent further erosion problems from occurring.

Table 12 Pastureland Best Management Practices Effectiveness

BMP	Targeted Pollutant in Surface Water	Effectiveness of BMP
Pasture & hayland planting	Sediment	substantial
Irrigation water management	Sediment	substantial
Critical area planting	Sediment	substantial
Fencing to distribute grazing	Sediment	neutral
Prescribed Grazing	Sediment	substantial
Mechanical Forage Harvest	Sediment	moderate
Irrigation water conveyance	Sediment	moderate
Appropriate irrigation system	Sediment	moderate
Filter strip/buffer	Sediment	moderate
Pond to distribute grazing	Sediment	slight-substantial
Spring development to distribute grazing	Sediment	slight
Brush management	Sediment	slight
Nutrient management	Nutrients	substantial
Waste Utilization	Nutrients	substantial
Irrigation water management	Nutrients	substantial
Pasture & hayland planting	Nutrients	substantial
Use Exclusion to exclude livestock from streams	Nutrients	neutral
Pond	Nutrients	slight-moderate
Buffers	Nutrients	slight-substantial
Fencing to distribute grazing	Nutrients	neutral
Prescribed Grazing	Nutrients	moderate
Forage harvest mgt.	Nutrients	slight-moderate
Waste utilization	Oxygen Demand	moderate
Pond	Oxygen Demand	slight
Nutrient management	Oxygen Demand	substantial
Use Exclusion to exclude livestock from streams	Oxygen Demand	slight-moderate
Fencing to distribute grazing	Oxygen Demand	neutral
Filter strip/buffers	Oxygen Demand	substantial
Prescribed grazing	Oxygen Demand	slight
Forage harvest management	Oxygen Demand	slight
Pasture and hayland planting	Oxygen Demand	slight
Irrigation water management	Oxygen Demand	slight
Waste utilization	Bacteria	neutral
Pond	Bacteria	slight worsening
Nutrient management	Bacteria	slight
Filter strip/buffers	Bacteria	slight
Spring development to distribute grazing	Bacteria	slight
Irrigation water management	Bacteria	substantial

Median of Average Influent and Effluent Concentrations of Best Management Practices

Constituents	Sample Location	Detention Pond (n=25)[1]	Wet Pond (n=46)[1]	Wetland Basin (n=19)[1]	Biofilter (n=57)[1]	Media Filter (n=38)[1]	Hydrodynamic Devices (n=32)[1]	Porous Pavement (n=6)[1]
Suspended Solids (mg/L)	Influent	72.65 (41.70-103.59)	34.13 (19.16-49.10)	37.76 (18.10-53.39)	52.15 (41.41-62.88)	43.27 (27.25-59.58)	39.61 (21.95-76.27)	xx
	Effluent	31.04 (16.07-46.01)	13.37 (7.29-19.45)	17.77 (9.26-26.29)	23.92 (15.07-32.78)	15.86 (9.74-21.98)	37.67 (21.28-54.02)	16.96 (5.90-48.72)
Total Cadmium (µg/L)	Influent	0.71 (0.45-1.28)	0.49 (0.20-0.79)	0.36 (0.11-0.60)	0.54 (0.40-0.67)	0.25 (0.12-0.49)	0.74 (0.37-1.11)	xx
	Effluent	0.47 (0.25-0.87)	0.27 (0.12-0.61)	0.24 (0.11-0.55)	0.30 (0.26-0.35)	0.19 (0.1-0.37)	0.57 (0.25-1.33)	xx
Dissolved Cadmium (µg/L)	Influent	0.24 (0.15-0.33)	0.19 (0.10-0.28)	xx	0.25 (0.21-0.28)	0.16 (0.11-0.21)	0.33 (0.11-0.55)	xx
	Effluent	0.25 (0.17-0.36)	0.11 (0.08-0.15)	xx	0.21 (0.19-0.23)	0.13 (0.10-0.18)	0.31 (0.13-0.71)	xx
Total Copper (µg/L)	Influent	20.14 (8.41-31.79)	8.91 (5.29-12.52)	5.65 (2.67-38.61)	31.93 (25.25-38.61)	14.57 (10.87-18.27)	15.42 (9.20-21.63)	xx
	Effluent	12.10 (5.41-18.80)	6.36 (4.70-8.01)	4.23 (0.62-7.83)	10.66 (7.68-13.68)	10.25 (8.21-12.29)	14.17 (8.33-20.01)	2.78 (0.88-8.78)
Dissolved Copper (µg/L)	Influent	6.66 (0.73-12.59)	7.33 (5.40-9.26)	xx	14.15 (10.14-18.16)	7.75 (4.55-10.96)	13.59 (9.82-17.36)	xx
	Effluent	7.37 (3.28-11.45)	4.37 (3.73-5.73)	xx	8.40 (5.65-11.45)	9.00 (7.28-10.72)	13.92 (4.40-23.44)	xx
Total Chromium (µg/L)	Influent	7.36 (5.49-9.88)	6.00 (3.58-10.08)	xx	5.63 (4.49-7.05)	2.18 (1.66-2.86)	4.07 (2.39-6.91)	xx
	Effluent	3.18 (2.10-4.84)	1.44 (0.79-2.66)	xx	4.64 (3.08-6.98)	1.48 (0.82-2.70)	3.52 (2.14-5.80)	xx
Total Lead (µg/L)	Influent	25.01 (12.06-37.95)	14.36 (8.32-20.40)	4.62 (1.43-11.89)	19.53 (10.11-28.95)	11.32 (6.09-16.55)	18.12 (5.70-30.53)	xx
	Effluent	15.77 (4.67-26.87)	5.32 (1.63-9.01)	3.26 (2.31-4.22)	6.70 (2.81-10.59)	3.76 (1.08-6.44)	10.56 (4.27-16.85)	7.88 (1.64-37.96)
Dissolved Lead (µg/L)	Influent	1.25 (0.33-2.17)	3.40 (1.12-5.68)	0.50 (0.33-0.67)	2.25 (0.77-3.74)	1.44 (1.05-1.82)	1.89 (0.83-2.95)	xx
	Effluent	2.06 (0.93-3.19)	2.48 (0.98-5.36)	0.87 (0.85-0.89)	1.96 (1.26-2.67)	1.18 (0.77-1.60)	3.34 (2.22-4.47)	xx
Total Zinc (µg/L)	Influent	111.56 (51.50-171.63)	60.75 (45.23-76.27)	47.07 (24.47-90.51)	176.71 (128.28-225.15)	92.34 (52.29-132.40)	119.08 (73.50-164.67)	xx
	Effluent	60.20 (20.70-99.70)	29.35 (21.13-37.56)	30.71 (12.80-66.69)	39.83 (28.01-51.56)	37.63 (16.80-58.46)	80.17 (52.72-107.61)	16.60 (5.91-46.64)

Dissolved Zinc (µg/L)	Influent	26.11 (5.20-75.10)	47.46 (37.65-57.27)	xx	58.31 (32.46-79.16)	69.27 (37.97-100.58)	35.93 (4.96-66.90)	xx
	Effluent	25.84 (10.75-40.93)	32.86 (17.70-48.01)	xx	25.40 (18.71-32.09)	51.25 (29.04-73.46)	42.46 (10.38-74.55)	xx
Total Phosphorus (mg/L)	Influent	0.19 (0.17-0.22)	0.21 (0.13-0.29)	0.27 (0.11-0.43)	0.25 (0.22-0.28)	0.20 (0.15-0.26)	0.24 (0.01-0.46)	xx
	Effluent	0.19 (0.12-0.27)	0.12 (0.09-0.16)	0.14 (0.04-0.24)	0.34 (0.26-0.41)	0.14 (0.11-0.16)	0.26 (0.12-0.48)	0.09 (0.05-0.15)
Dissolved Phosphorus (mg/L)	Influent	0.09 (0.06-0.13)	0.09 (0.06-0.13)	0.10 (0.04-0.22)	0.09 (0.07-0.11)	0.09 (0.03-0.14)	0.06 (0.01-0.11)	xx
	Effluent	0.12 (0.07-0.18)	0.08 (0.04-0.11)	0.17 (0.03-0.31)	0.44 (0.21-0.67)	0.09 (0.07-0.11)	0.09 (0.04-0.13)	xx
Total Nitrogen (mg/L)	Influent	1.25 (0.83-1.66)	1.64 (1.39-1.94)	2.12 (1.58-2.66)	0.94 (0.94-1.69)	1.31 (1.19-1.42)	1.25 (0.33-2.16)	xx
	Effluent	2.72 (1.81-3.63)	1.43 (1.17-1.68)	1.15 (0.82-1.62)	0.78 (0.53-1.03)	0.76 (0.62-0.89)	2.01 (1.37-2.65)	xx
Nitrate-Nitrogen (mg/L)	Influent	0.70 (0.35-1.05)	0.36 (0.21-0.51)	0.22 (0.01-0.47)	0.59 (0.44-0.73)	0.41 (0.30-0.51)	0.40 (0.06-0.73)	xx
	Effluent	0.58 (0.25-0.91)	0.23 (0.13-0.37)	0.13 (0.07-0.26)	0.60 (0.41-0.79)	0.82 (0.60-1.05)	0.51 (0.08-1.34)	xx
TKN (mg/L)	Influent	1.45 (0.97-1.94)	1.26 (1.03-1.49)	1.15 (0.81-1.48)	1.80 (1.62-1.99)	1.52 (1.07-1.96)	1.09 (0.52-1.67)	xx
	Effluent	1.89 (1.58-2.19)	1.09 (0.87-1.31)	1.05 (0.82-1.34)	1.51 (1.24-1.78)	1.55 (1.22-1.83)	1.48 (0.87-2.47)	1.23 (0.44-3.44)

Chart from www.bmpdatabase.org. The efficiency is not reported as a percentage of pollutant removal because Percent Removal is primarily a function of influent quality.

7.0 MAKING THE IMPLEMENTATION PLAN WORK

In order to implement BMPs and other conservation practices which reduce the NPS load in the Bayou Pierre watershed so that it meets its designated uses and is no longer listed on the 303(d) list, it will be necessary to have programs that provide technical assistance, funding, incentives, as well as foster a sense of stewardship. Many of these programs that are designed to assist the landowner are already in place. The LDEQ's Nonpoint Source Unit provides monies distributed through the USEPA under Section 319 of the CWA. The funds are utilized to implement BMPs for all types of land uses within the watershed in order to reduce and/or prevent the NPS pollutants and achieve the river's designated uses. The USDA and NRCS are federal government agencies that have several such programs made available by way of the Farm Security and Rural Investment Act of 2002. These programs are made available through the local Soil and Water Conservation District (SWCD). The NRCS has a list of BMPs for almost all types of agriculture and programs to facilitate their use.

Parish-wide cooperation and coordination will be necessary in order to protect the water quality within the watershed. Though challenging, it is an opportunity and reason for leaders, officials, and local citizens to come together for a common interest. The watershed approach helps build new levels of cooperation and coordination, which is necessary to successfully control NPS loading.

7.1. Regulatory Authority

Section 319 of the Clean Water Act (PL 100-4, February 4, 1987) was enacted to specifically address problems attributed to non-point sources of pollution. Its objective is to restore and maintain the chemical, physical, and biological integrity of the nation's waters (Sec. 101; PL 100-4). Section 319 directs the governor of each state to prepare and submit a non-point source management program for reduction and control of pollution from non-point sources to navigable waters within the state by implementation of a four-year plan, submitted within 18 months of the day of enactment (LDEQ, 2000).

In response to the federal law, the State of Louisiana passed the Revised Statute 30:2011, which had been signed by the Governor in 1987, as Act 272. Act 272 designated the Louisiana Department of Environmental Quality (LDEQ) as the Lead Agency to develop and implement of the State's Non-point Source Management Plan. LDEQ's office of water resources (OWR) was charged with the responsibility to protect and preserve the quality of waters in the State and has developed the non-point source management program, ground water quality program and a conservation and management plan for estuaries. These programs and plan were developed in coordination with the appropriate State agencies such as the Department of Natural Resources, the Department of Wildlife and Fisheries, the Department of Agriculture and Forestry and the State Soil and Water Conservation Committees in various jurisdictions (La.R.S. 30:20). LDEQ's office of water resources is therefore responsible for receiving federal funds to ensure clean water, providing matching State funds when required and complying with terms and conditions necessary to receive federal grants.

The water quality standards are described in LAC 33:IX.1101.D in chapter 11 (LDEQ, 2003). These standards are applicable to surface waters of the state and are utilized through the waste load allocation and permit process to develop effluent limitations for point source discharges to surface waters of the State. The water quality standards also form the basis for implementing the best management practices for control of non-point sources of water pollution.

Chapter 11 also describes the anti-degradation policy (LAC 33:IX.1109.A.2) which states that the administrative authority will not approve any wastewater discharge or certify any activity for federal permit that would impair water quality or use of state waters. Waste discharges must comply with applicable state and federal laws for the attainment of water quality goals. Any new, existing, or expanded point source or non-point source discharging into state waters, including land clearing, which is the subject of a federal permit application, will be required to provide the necessary level of waste treatment to protect state waters as determined by the administrative authority. Further, the highest statutory and regulatory requirements shall be achieved for all existing point sources and best management practices (BMPs) for non-point sources. Additionally, no degradation shall be allowed in high-quality waters that constitute outstanding natural resources, such as waters of ecological significance as designated by the office. Those water bodies presently designated as outstanding resources are listed in LAC 33:IX.1123.

8.2. Actions Being Implemented by LDEQ

The LDEQ is presently designated the lead agency for implementation of the Louisiana Nonpoint Source Program. The LDEQ Nonpoint Source Unit provides USEPA §319(h) funds to assist in implementation of BMPs and to address water quality problems on subsegments listed on the §303(d) list or those subsegments which are located within Category I Watersheds as identified under the Unified Watershed Assessment of the Clean Water Action Plan. USEPA §319(h) funds are utilized to sponsor cost sharing, monitoring, and education projects. These monies are available to all private, for profit, and nonprofit organizations that are authenticated legal entities, or governmental jurisdictions including: cities, counties, tribal entities, federal agencies, or agencies of the State. Presently, LDEQ is cooperating with such entities on nonpoint source projects which are active throughout the state.

Although, LDEQ presently has no active projects in the watershed itself, LDEQ has entered into a cooperative agreement with the Acadiana RC&D to serve as the watershed coordinator and to lead discussions with stakeholders in the basin.

8.3. Actions Being Implemented by other Agencies

Louisiana Department of Agriculture and Forestry
The LDAF has worked on development of action items that were contained in the Comprehensive Management Plan. Their soil and water conservation districts are the primary link with the farmers and landowners that can implement best management

practices on their lands. As the Action Items contained with the management plan are addressed, these districts will continue to play a major role in their implementation.

Police Juries
Louisiana is unique in the nation in that it has parishes that are governed in most cases by police juries. The jury system provides government close to the people. The jury performs the legislative functions of enacting ordinances, establishing programs and setting policy. It is also an administrative body in that it is involved in preparing the budget, hiring and firing personnel, spending funds, negotiating contracts and in general, directing the activities under its supervision.

Master Farmers
The Master Farmer Program (developed by Louisiana State University Agricultural Center) is to encourage on the ground BMP implementation with a focus on environmental stewardship. The LSU AgCenter is promoting the Master Farmer Program to help farmers address environmental stewardship through voluntary, effective, and economically achievable BMPs. The program will be implemented through a multi-agency organization partnership, including the Louisiana Farm Bureau (LFB), the Natural Resources Conservation Service (NRCS), the Louisiana Cooperative Extension Service (LCES), USDA-Agriculture Research Service (ARS), LDEQ, and agricultural producers.

The Master Farmer Program will have three components: environmental stewardship, agricultural production, and farm management. The environmental stewardship component will have three phases. Phase I will focus on the environmental education and crop-specific BMPs and their implementation. Phase II of the environmental component will include in-the-field viewing of implemented BMPs on "Model Farms." Farmers will be able to see farms that document BMP effectiveness in reducing sediment runoff. Phase III will involve the development and implementation of farm-specific, comprehensive conservation plans by the participants. A member must participate in all three phases in order to gain program status.

This program can help to initiate and distribute the use of BMPs throughout the watershed. Participants will set an example for the rest of the agricultural community and will work closely with NRCS staff and other Master Farmers to identify potential problem areas in the watershed. They will receive information on new and innovative ways to reduce soil and nutrient loss from their fields. They will be kept informed of the water quality monitoring occurring in the watershed and alerted of any degradation or improvements. Farmers, who participate and complete the Master Farmer Program, receive the distinction of a "master farmer", which implies that they have completed all the coursework in environmental stewardship, production, and management/marketing. Voluntary implementation of economically achievable and effective BMPs represents a workable means of reducing agriculture's contribution to the water quality problems.

Local Civic Organizations
The local civic and service organizations are comprised of key leaders within the community. These people care about their community and want to work on programs that improve the environment and their local economy. They are the farmers, the homeowners, and the city and parish leaders that need to be involved in programs that educate the people about their water quality issues. They will be included in the

educational outreach programs planned for TMDLs and watershed management and are viewed as local decision-makers in how these programs are implemented.

Local Universities, Schools
Universities and schools have such an opportunity to become involved in water quality, habitat protection and wetland issues that exist across the Vermilion-Tech Basin. Many of them have and already conduct their own water quality testing programs and have become involved in environmental education. As LDEQ works on watershed implementation, there will be opportunity for their involvement in many aspects of the programs. Surveys of home sewage systems, habitat assessment along bayous and streams, participation in demonstration projects and educational programs are all examples of activities that local schools and university students and teachers can become involved in. In some parts of the state, students have restored urban streams and worked with the Corp of Engineers to protect wetlands. They have innovative ideas and enjoy working on local issues where short-term progress can be seen.

Louisiana Cooperative Extension Service
LCES plays a very important role in the educational component of the NPS Management Program. They provide the farmers, local citizens, and science teachers and children with information on water quality, wetlands, habitat protection and a host of other environmental issues. Summer camps offer high school students the opportunity to learn about coastal environments, marshes, and estuaries. Marsh Maneuvers has been a very popular learning experience for students to actually spend a week in the marsh, learning about every aspect of its unique ecology. LCES has hosted and participated in workshops for science teachers on water quality, nonpoint source pollution, watershed management and wetland protection. They are the backbone of the state's educational system for adults and children on agriculture and environmental issues, and it is anticipated that they will continue to be a major partner in this important area.

USDA and NRCS
The U.S. Department of Agriculture (USDA) and Natural Resource Conservation Service (NRCS) offers landowners financial, technical, and educational assistance to implement conservation practices and/or BMPs on privately owned land to reduce soil erosion, improve water quality, and enhance crop land, forest land, wetlands, grazing lands and wildlife habitat.

The new Food, Conservation, and Energy Act of 2008, known as the 2008 Farm Bill, will provide conservation opportunities for farmers and ranchers for years to come. The new provisions build on the conservation gains made by farmers and ranchers through the 1985, 1996 and 2002 Farm Bills. They simplify existing programs and create new programs to address high priority environmental goals. Although most of these programs are designed to assist the agriculture industry, there may be cases where they may be utilized for conservation practices for other types of land uses.

A complete list of agriculture BMPs is provided by the NRCS in their "Technical Guide Handbook". The handbook includes a description of each BMP and their recommended uses. Each BMP is listed by a "code", i.e. Field Border (386). The following includes a brief summary of the programs available through the local SWCD under the oversight of USDA and NRCS. The descriptions of the programs

are general and are based on information available at the time; key points subject to change as rules established.

2008 Farm Bill Conservations Programs and Potential Funding Sources:
Environmental Quality Incentive Program (EQIP) provides 75% - 90% cost share for environmentally beneficial structural and management alterations, primarily 60% to livestock operations. Applications prioritized for benefits. Considered the "Working Lands" program. 2008 Farm Bill total funding allocation is $13,546,218.

Wildlife Habitat Incentive Program (WHIP) provides 75% - 90% cost share for the costs of wildlife habitat restoration and enhancement on private lands. Eligible to private property owners (and lessees) for installing riparian buffers, native pine & hardwoods, wildlife corridors, and other wildlife enhancing measures, 5 – 10 year contracts. The 2008 Farm Bill total funding allocation is $660,314. The 2008 Farm Bill has applied 7,964 acres in this program.

Wetland Reserve Program (WRP) is a voluntary program for wetland restoration, enhancement, and protection on private lands. WRP provides annual payments and restoration costs for 10 year, 30 year, or perpetual easements on prior converted wetlands. Louisiana leads the US in WRP participation. The 2008 Farm Bill has applied 11,803 acres in this program and expanded the program to purchase long-term easements and cost sharing to agriculture producers.

Conservation Reserve Program (CRP)
The 1985 Farm Bill established CRP as a voluntary program to protect highly erodible and environmentally sensitive lands. Has a positive value on rural environment by improving soil, water, and wildlife. Extends a pilot sub-program called the Conservation Reserve Enhancement program. The 2008 Farm Bill has applied 41,934 acres in this program.

Conservation Security Program (CSP) is a new national incentive payment program for maintaining and increasing farm and ranch stewardship practices. The CSP is designed to correct a policy disincentive in which independently conducted resource stewardship has disqualified many farmers from receiving conservation program assistance. Features an optional "tiered" level of farmer participation where higher tiers receive greater funding for greater conservation practices. The 2008 Farm Bill has applied 65 acres in this program.

Grassland Reserve Program (GRP) is a voluntary program that helps landowners and operators restore and protect grassland, including rangeland, pastureland, shrubland, and certain other lands, while maintaining the areas as grazing lands. GRP easements would be divided 40/60 between agreements of 10, 15, or 20-years and agreements and easements for 30-years and permanent easements to restore grassland, rangeland, and pasture through annual rental payments. The 2002 Farm Bill established GRP and authorizes $254 million in funding for 2 million acres through 2007.

Small Watershed Rehabilitation Program (SWRP) provides essential funding for the rehabilitation of aging small watershed impoundments and dams that have been constructed over the past 50 years. The 2002 Farm Bill the established program and the total funding allocation is $275 million through 2007.

"Sodbuster" is a conservation compliance requirement that was established by the 1985 Farm Bill to discourage plowing of erosion-prone grasslands for use as cropland. Eligibility for program benefits is tied to an approved conservation plan. Compliance is required.

"Swampbuster" was established in the 1985 Farm Bill as a conservation compliance mechanism to discourage draining of wetlands for use as cropland. Eligibility for program benefits can be lost for any wetland converted after 12/23/85. Compliance is required.

In addition to the programs mentioned, the following organizations have signed an MOU with LDEQ within the state's NPS Management Plan that each will aid LDEQ in achieving the goals of the management plan:

Louisiana Department of Agriculture and Forestry
Louisiana Department of Health and Hospitals
Louisiana Department of Wildlife and Fisheries
Louisiana Department of Transportation and Development
Louisiana Department of Natural Resources
Louisiana State University Agricultural Center
Natural Resources Conservation Service
USDA – Farm Services Agency
Louisiana Forestry Association
US Fish and Wildlife Service
USDA Forest Service
US Army Corps of Engineers
US Geological Survey
Federal Emergency Management Agency
Louisiana Farm Bureau Federation

8.4. Implementation and Maintenance

Louisiana Department of Agriculture and Forestry maintains information on the costs of BMP installation. Listed below are some practices that may be helpful in the Bayou Boeuf watershed. Within a BMP, there may be multiple variations, ranging in price, complexity and materials. These shown are only a starting point. Many of these practices are eligible for funding under various government programs.

Table 13 Cost of BMP Implementation

Practice Code	Practice Name	Component	Unit	2008 Average Cost ($)
100	Comprehensive nutrient mgt. plan	Comprehensive nutrient management plan	Flat rate	350.00
329	Residue and tillage management	No Till/Strip Till/Direct Seed	Flat rate	25.00
340	Cover crop	Establishment of seasonal cover crop	Flat rate	20.00
344	Residue management	Crop residue management (seasonal)	Flat rate	7.50
350	Sediment basin	Sediment basin (installed, mobilization, earthwork, outlet structure)	acre	2.45
386	Field border	Native species, 3 or more species mix (seedbed prep, seed, planting)	acre	150.00
393	Filter strip	Native species, 3 or more species mix (seedbed prep, seed, planting)	acre	150.00
393	Filter strip	Earthwork (smoothing, shaping, and mobilization)	cubic yard	1.64
449	Irrigation water management	Flowmeter (meter and installation of irrigation pipeline, per inch of pipe)	acre	81.00
590	Nutrient management	Precision Agriculture – with Yield Monitor	acre	36.00

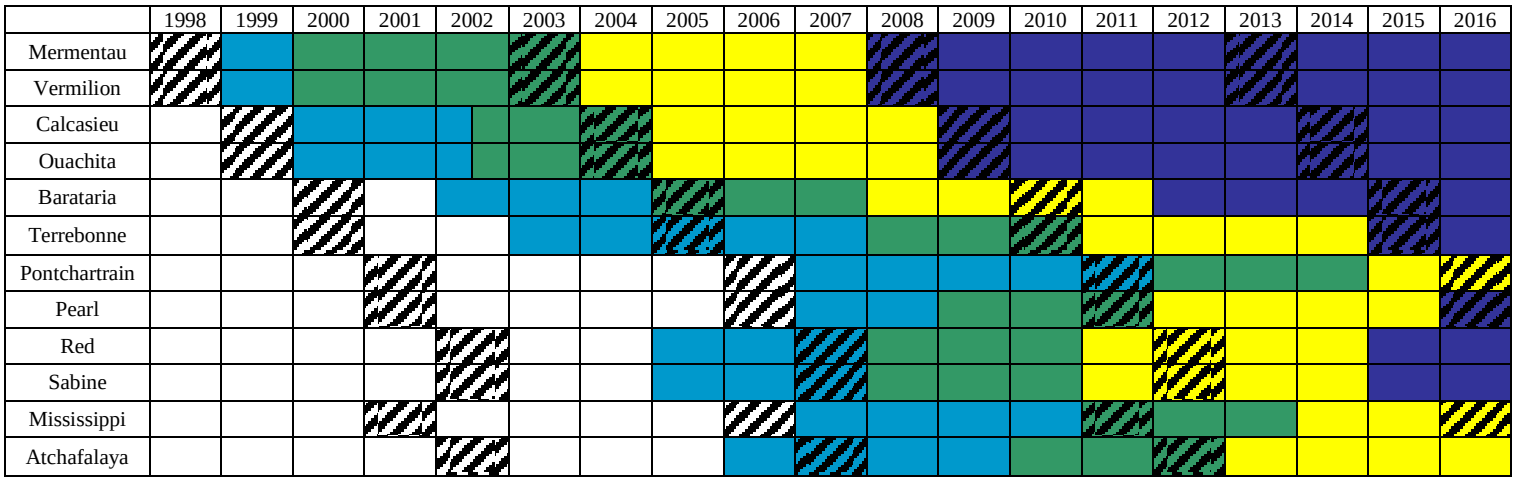
9.0 TIMELINE FOR IMPLEMENTATION

9.1. Tracking and Evaluation

The Integrated Report [305(b) and 303(d)] provides information on which water bodies are impaired or not in full support of their designated uses. The Integrated Report is a summary of the water quality status for each of the water bodies throughout the state. Those listed, impaired water bodies are then scheduled for TMDL development. Water bodies can be delisted, or removed from the 303(d) list, because new data indicate that the water body is meeting its designated uses.

Since 2004, LDEQ collects data on a four-year rotation of active monitoring sites. (Prior to 2004, data were collected on a five-year rotation.) These findings are used to compile the biennial Integrated Report. As previously mentioned, LDEQ has recommended that Bayou Boeuf be de-listed for Primary Contact Recreation in the 2008 Integrated Report. A final decision has not been made as of this writing.

It is the objective of LDEQ to reduce the nonpoint source pollutant loads that are calculated for the Vermilion-Teche River Basin. The goal is water quality improvement and restoration of designated uses. The four-year basin cyclic water quality-monitoring program will be the basis for tracking reduced pollutant loading. LDEQ began it latest round of sampling on Bayou Boeuf, Station 0668, in October 2008. Sampling is scheduled to continue until September 2009.



1. Black Stripes = Collect Water Quality Data to Develop Total Maximum Daily Loads (TMDLs) and to Track Water Quality Improvement at the Watershed Level [Objective 1]
2. Light Blue = Develop Total Maximum Daily Loads for the Watersheds on the 303(d) List [Objective 2]
3. Green = Develop Watershed Management Plans to Implement the NPS Component of the TMDL [Objective 3]
4. Yellow = Implement the Watershed Management Plans [Objectives 4-8]
5. Dark Blue = Develop and Implement Additional Corrective Actions Necessary to Restore the Designated Uses to the Water Bodies [Objective 9-10]

10.0 SUMMARY OF THE WATERSHED IMPLEMENTATION PLAN

Bayou Boeuf does not meet the water quality standards for dissolved oxygen and nutrients. With the aim of restoring its designated use of fish and wildlife propagation, the models indicate that there needs to be a watershed-wide 50% decrease in man-made nonpoint sources, 359% decrease in fecal coliform loading, and 39.5% reduction of TDS loading in order to meet the required standards set forth in the summer critical season. To meet this goal, a collaborative effort from the citizens of the area, special interest groups, and the government, is essential. These problems should be addressed through basin-wide educational programs encompassing restoration and management strategies for forestry, agriculture, and pastureland. Best Management Practices and regulations are available for reducing nonpoint source pollutant loads from these causes; and if followed properly, should reduce most of the suspected causes of impairments in the watershed. Financial support can be provided for some of these activities through USEPA §319(h) funds or by financial, technical, or educational assistance through the USDA.

The short-term goal for managing these water quality problems is to work with the local community, decision-makers, state and federal agencies to implement management measures and best management practices that can reduce the concentration of sediment and nutrients leaving the land during rain fall events.

The long-term water quality goal is to be able to measure a reduction in the in-stream concentration of these pollutants and to restore the designated uses for the water body. From the implementation of this watershed plan, LDEQ expects to gain better working relationships among organizations; a better use of science to understand how human activities affect our water resources; a better protection for our water bodies; and most importantly, cleaner water. Ultimately this responsibility lies on the shoulders of everyone who lives, works or plays in the Bayou Boeuf Watershed. Public participation is critical throughout plan development and implementation, as ultimate success of any Watershed Protection Plan depends on stewardship of the land and water resources by landowners, businesses, and residents of the watershed. The Bayou Boeuf Watershed Protection Plan defines a strategy and identifies opportunities for widespread participation of stakeholders across the watershed to work together and as individuals to implement voluntary practices and programs that restore and protect water quality in the watershed.

The LDEQ is continuing to implement a watershed approach to the surface water quality monitoring. In 2004, a four year sampling cycle replaced the previous five year cycle. Approximately one quarter of the state's watersheds will be sampled in each year so that all of the state's watersheds will be sampled within the four year cycle. This will allow the LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. The implementation of best management practices to control and reduce runoff of soil and oxygen-demanding pollutants from nonpoint sources in the watershed will control and reduce the nutrient loading from the suspected sources. As the monitoring results are evaluated at the end

of each year, waterbodies may be added to or removed from the 303(d) list. The Plan will act as a living document; subject to revision as the performance is evaluated.

Although some of the BMPs and their recommended courses of action were described within this plan, a consolidated list of BMPs recommended for each of these land uses can be viewed in the State of Louisiana Water Quality Management Plan, Volume 6 (LDEQ, 2000). Detailed BMP manuals for agronomic crops, rice, poultry, sugar cane, dairy, sweet potato, swine, beef, and aquaculture have been produced by LSU AgCenter and are available on their website http://www.lsuagcenter.com/Subjects/bmp/index.asp. For all entities involved in silvicultural operations, the Recommended Forestry Best Management Practices for Louisiana manual has been and will continue to be an invaluable source of information and recommendations (LDEQ, 2000).

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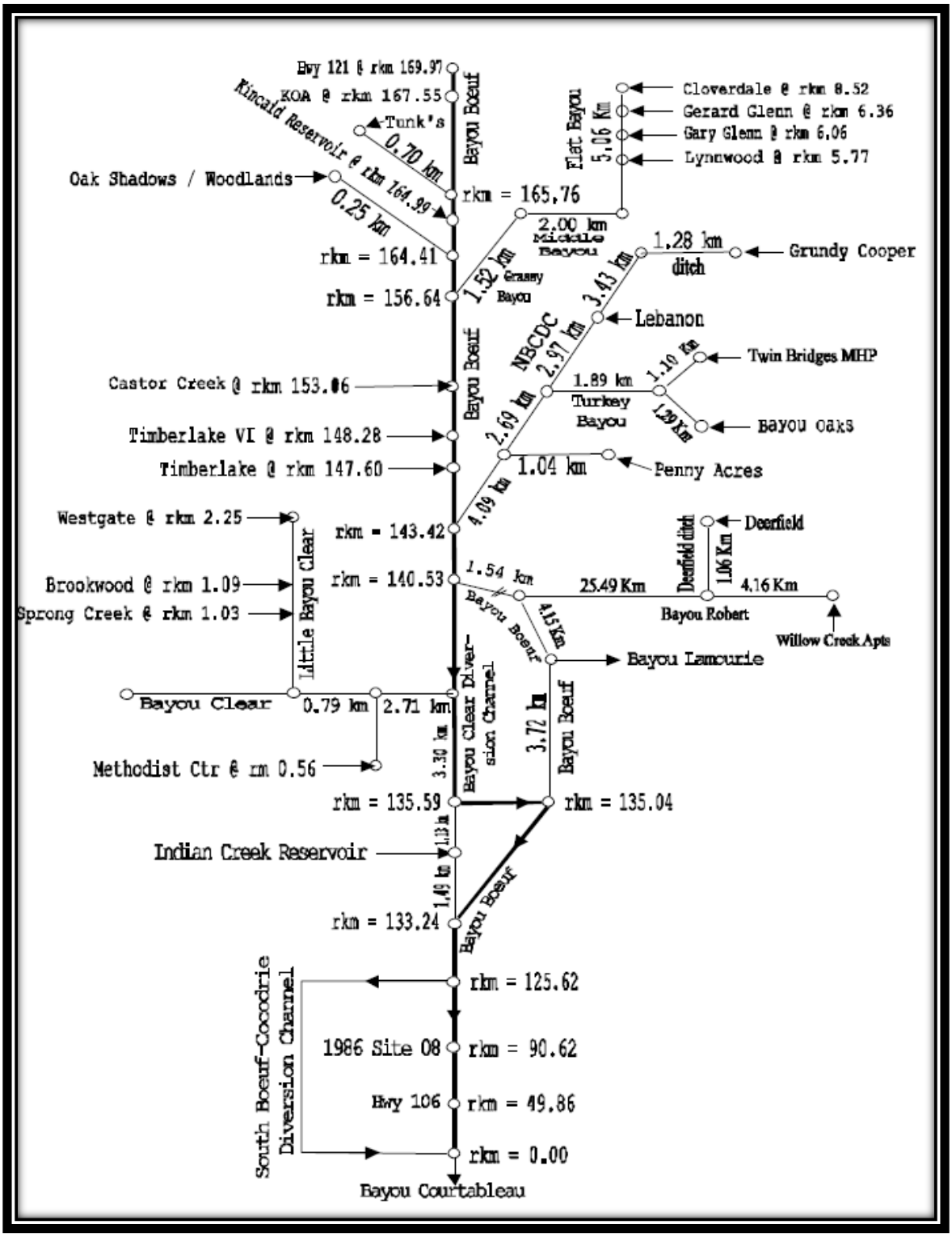
APPENDIX



Vector Diagram for Bayou Boeuf Watershed